Industrial waste analysis & options paper:

Project summary report

for

Waste and Resource Recovery Board (WRR Board)

Final report

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Abbreviations and acronyms used in this report

ABS	Australian Bureau of Statistics
AER	Annual Environmental Review
ANZSIC	Australia and New Zealand Standard Industrial Classification
C&D waste	Construction and Demolition Waste
C&I waste	Commercial and Industrial Waste
DSG	Department of State Growth (Tasmanian Government)
EIP	Environmental Improvement Programmes
EPA	Tasmanian Environmental Protection Authority
EPN	Environment Protection Notice
EPS	Expanded Polystyrene
GHG emissions	Greenhouse Gas Emissions
HDPE	High Density Polypropylene
HVF	High Viscosity Fuel
IBC	Intermediate Bulk Container
ITas	Infrastructure Tasmania
LDPE	Low Density Polypropylene
MRF	Materials Recovery Facility
MSW	Municipal Solid Waste
NRE Tas	Department of Natural Resources & Environment, Tasmanian Government
OTR tyre	Off The Road Tyre
PCB	Polychlorinated Biphenyls
PE	Polyethylene
PFAS	Per- and Polyfluoroalkyl Substances
PP	Polypropylene
PPE	Personal Protective Equipment
PVC	Poly Vinylchloride
PS	Polystyrene
SCL	Spent Cell Liner or Spent Cell Lining (also known as Spent Pot Liner)
TMEC	Tasmanian Minerals, Manufacturing & Energy Council
TRL	Technology Readiness Level
WPC	Wood Plastic Composite
WRR Board	Waste & Resource Recovery Board
WWTP	Waste Water Treatment Plant

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Executive Summary

The Waste and Resource Recovery Board (WRR Board) has requested a body of work that investigates, reports on and provides options in relation to the management of industrial waste in Tasmania, with a particular focus on waste generated in the north of the state. This report covers the findings from this work, with options for managing a priority set of industrial waste streams in alignment with the waste hierarchy and circular economy principles, compared to prevailing practices.

Purpose of the work

The core purpose in completing this project is to provide research in support of well informed and targeted actions and investments, for the WRR Board's consideration. In meeting this purpose, a number of contributing tasks were fulfilled as follows:

- Solid industrial waste streams in northern Tasmania were characterised.
- Priority streams were nominated, to explore and identify circular economy solutions.
- Solutions to priority streams, i.e. that reflect Tasmanian context and opportunities, were put forward – accompanied with insights on factors that may impede their uptake.
- The Board was informed of relevant activities and policy/regulatory settings for their consideration and possible implementation, to bring those solutions to reality.

Link to the *Waste and Resource Recovery Strategy 2023-2026*

The current *Waste and Resource Recovery Strategy* focuses on setting priorities and laying foundations for more action-oriented iterations to the strategy, post 2026. This project helps to set the WRR Board's direction and priorities for managing industrial waste across Tasmania, commencing with a focus on northern Tasmanian wastes.

The priority waste streams identified in this report provides a starting point limited to priority materials generated by activities from ANZSIC Industry Divisions A through D, with other priorities potentially arising from other sectors. The project signposts potential areas of activity and resourcing for the Board's consideration, in acting on those priority streams.

Scope of materials and industries

This project is limited to a characterisation and analysis of priority waste streams originating from four ANZSIC Industry Divisions as set out below. The research is confined to those streams that are solid and inorganic, although may include organic waste streams that may be prone to contamination with or are affected by the presence of non-organic materials.

ANZSIC Industry Division	Includes industry categories
A	Limited to aquaculture related activities only
B	All mining related activities
C	All manufacturing related activities
D	All activities related to water, waste and recycling, energy & gas sectors

Project delivery & timelines

This project was delivered across two stages, from February 2025 through to end of July 2025:

- Part 1: Initial industry research and identification of priority streams
- Part 2: Research into options and solutions for priority streams, and recommended actions to bring forward solutions.

In delivering a final report (presenting findings from both parts), the project team briefed the WRR Board on draft findings, and incorporated feedback into producing a final version.

Priority waste streams

In completing the first part of this project, a total of sixteen streams from the four ANZSIC Industry Divisions were identified as priorities for managing industrial wastes in northern Tasmania (see table below). The determination of their priority took account of industry perspectives on their challenges and on the importance in moving towards circular economy practices, as well as being factored by other descriptors such as:

- The extent and maturity of circular economy solutions suitable to the stream
- Hazards inherent to the stream (e.g. through being recognised as a controlled waste)
- The anticipated market value of resources lost due to current practices
- Social and environmental risks and impacts associated with current practices.

Stream
ANZSIC Division A – Agriculture (Aquaculture only)
Plastic ropes & flotation equipment (and other fish farm plastics not recycled or reused)
Soft and rigid plastic packaging, including packaging contaminated with fish waste
ANZSIC Division B – Mining
Recyclable mining plant & equipment contaminated with removable hazardous materials
Recyclable mining plant & equipment (uncontaminated)
Mining sector rubber containing equipment – tyres, tracks, conveyors, mill lining, rubber hosing
ANZSIC Division C – Manufacturing
Byproduct from metal smelting, refining & alloying
Damaged / worn heavy duty machinery & equipment used in metal smelting, refining & alloying
Boiler ash generated from the timber products industry (from combusting wood chip and sawdust fuel)
ANZSIC Division D – Water, Energy production & supply, Gas supply, Waste services
Alum sludge used in drinking water treatment
Plastic intermediate bulk containers (IBCs) containing coagulated residues
Biosolids generated by sewage treatment (mainly organic but may have inorganic loading)
Construction & demolition spoil dumps and concrete waste originating on water utility assets
Obsolete and broken water pipes made of concrete, plastic or galvanised iron
Complex power & energy system components (stators, rotors, transformers, mechanical governor systems)
Shredder floc generated by metal recycling activities
Materials Recovery Facility residues containing glass impacted by impurities

Identified solutions

In completing Part 2 of the project, solutions were put forward to achieve circular economy outcomes for each of these streams, as set out in the table below. Where relevant, it was noted that some level of pretreatment may be necessary before subjecting the waste stream to a final processing stage which would finalise the conversion of the waste stream into a usable resource.

Stream	Required pre-treatment	Recovery solution
ANZSIC Division A – Agriculture (Aquaculture only)		
Plastic ropes & flotation equipment (and other fish farm plastics not recycled or reused)	Identification of polymer type Clean up and removal of fouling, some disassembly	Mechanical recycling suitable for woven or braided plastics that may be heavily contaminated.
Soft and rigid plastic packaging, particularly packaging contaminated with fish waste	Washing to remove residual materials (fish waste, fish processing inputs)	Mechanical recycling suitable for soft and rigid plastics.
ANZSIC Division B – Mining		
Recyclable plant & equipment contaminated with removable hazardous materials	Washing, removal or neutralisation of hazardous contaminants Potentially size reduction	Mechanical recycling (specific to plant & equipment materials such as concrete, metal, plastic etc.).
Recyclable mining plant & equipment (uncontaminated)	Unearthing, if buried or used in mine voids Washing and mechanical cleaning to remove residue Potentially size reduction	Mechanical recycling (specific to materials such as concrete, metal, plastic etc.).
Mining sector rubber containing equipment	Downsizing to enable efficient transport and feeding into rubber recycling facility	Mechanical tyre recycling (Other rubber product recycling is less established).
ANZSIC Division C – Manufacturing		
Byproduct from metal smelting, refining & alloying	Uncertain but likely to require grinding to small particle size May be impractical to process byproduct with inherently high hazard characteristics	No established recovery path as yet (depending on the byproduct) Some development of inert aggregate (concrete, paving, road subbase) applications.
Damaged / worn heavy duty machinery & equipment used in metal smelting, refining & alloying	Uncertain but may require disassembly and/or downsizing (crushing / grinding)	Some machinery & equipment may be suitable for mechanical recycling. Other items may require a new solution due to lack of precedent.
Boiler ash generated from the timber products industry (from combusting wood chip and sawdust fuel)	May potentially require pH neutralisation, depending on application	No established recovery path as yet (one operator seeks solutions that are higher value than BAU use as fertiliser input).
ANZSIC Division D – Water, Energy production & supply, Gas supply, Waste services		
Alum sludge used in drinking water treatment	Dewatering and potential testing for contamination	No established recovery path as yet Some development of pavement, concrete brick, and backfilling applications.
Biosolids generated by sewage treatment (mainly organic but may have inorganic loading)	Dewatering and potential testing for contamination	No established recovery beyond land spreading and some composting. Some development of pyrolysis to destroy chemicals of concern ahead of value added soil improver applications.

Stream	Required pre-treatment	Recovery solution
Plastic IBCs containing coagulated residues	Washing to remove residual chemicals	Mechanical recycling or reuse suitable for rigid plastic containers.
Construction & demolition spoil dumps and concrete waste originating on water utility assets	Testing for contamination	Concrete and other construction and demolition waste crushing and use as civil project aggregate.
Obsolete and broken water pipes made of concrete, plastic or galvanised iron	Unearthing during repair and replacement works Washing and mechanical cleaning to remove residue Potentially size reduction	Mechanical recycling as used for concrete, plastic and galvanised iron streams.
Complex power & energy system components	Washing, removal or neutralisation of hazardous contaminants Potentially size reduction	Mechanical recycling of predominantly metal components.
Shredder floc generated by metal recycling activities	Separation into grades according to input materials Dust suppression Testing for contamination	No established recovery path as yet Some development of landfill daily cover; pyrolysis; and civil aggregate applications.
Materials Recovery Facility residues containing glass impacted by impurities	Sorting supported by automated optical technologies (beneficiation plant)	Crushing to specified grades for different civil applications.

While most of these streams could be recycled or reused using technologies that are proven in locations similar to Tasmania, further research and development and pilot scale demonstration for some streams need to be encouraged, including for:

- Byproducts from metal smelting, refining & alloying
- Damaged / worn heavy duty machinery & equipment used in metal smelting, refining & alloying (depending on details specific to the machinery and equipment in question)
- Boiler ash generated from the timber products industry
- Alum sludge used in drinking water treatment
- Biosolids generated in sewage treatment
- Shredder floc generated by metal recycling activities, noting the need to make certain that the material consistently represents a low risk in the context of how it is used.

For the remaining streams, a solution may be acted on more readily, once a number of potential technical and commercial barriers that could affect confident investment are addressed. These barriers may involve, for example, uncertainty that the solution can compete against alternatives with more tenuous circular economy outcomes, or concern that waste generators cannot deliver the input material at quantities and in a format compatible with how recovery operations need to be set up. These dependencies are explored in detail in the main report. They have been used to identify key areas where the WRR Board can take action, as covered in the section below.

For these streams, the research identifies that there is a case for direct co-funding to major recovery capacity as well as in preparatory activities to ensure feedstocks are able to be taken by existing and new recycling facilities. Funding provision may need to follow further research (e.g. solution-specific business cases), and engagement to ensure sufficient interest and commitment from relevant source industries – including industries outside the scope of this project.

Potential scope to take action on recognised priority streams

During Part 2 of this project, details of how the priority industrial wastes are generated in Tasmania were considered, alongside the conditions and dependencies that shape whether a given solution technology could be implemented for each stream.

In undertaking this analysis, the team considered the steps needed before a solution provider would be able to introduce the solution to the Tasmanian market, and the ongoing conditions needed to ensure that their operations are adequately de-risked. A set of actions for the WRR Board's consideration is put forward in the main report, with those actions tethered to individual waste streams that were prioritised during Part 1. Acting on these recommended steps will help to bring solutions specific to each waste stream to fruition.

When developing this scope of activities for the WRR Board and other public bodies to take on across all sixteen priority streams (i.e. aggregated from across all actions recommended in Chapter 5), the following four categories of activity emerge. At minimum, action is needed across all the activities in the diagram below, to have confidence that industrial waste is being placed on a pathway in line with the waste hierarchy and the circular economy across Tasmania.

Engagement & brokering	• Engage with industrial waste generators on preferred solutions • Engage with industrial waste generator on options for substitution • Brokering with solution providers to understand drivers and barrier to local presence
Spatial mapping & infrastructure planning	• Engage on & support mapping volumes from network-based or dispersed industries, and set priority locations & streams • Plan for & support development of heavy industry circular economy precincts near to areas of high concentration for industrial waste
Coordinated reforms & enforcement to drive the circular economy	• Develop R&D support framework for a circular economy for controlled wastes • Conduct regulatory reform and enforcement targeting stockpiling, onsite disposal and land spreading • Convene forums to address circular economy / regulatory tensions
Support for local commercialisation & investment	• Support circular economy technology, supply chain & end market business cases • Support techno-economic assessment and pilot recovery projects to strengthen the evidence for emerging solutions • Provide funding for technologies and related supply chain activities

Other actions to address industrial wastes

The project team recommends additional areas of action for the WRR Board as listed below. These recommendations drew on perspectives shared from across the industries consulted with during the project, as well as broader observations that could be drawn from patterns of evidence in practices and behaviours across the four ANZSIC Industry Divisions.

1. Continue industrial waste stream mapping and volume analysis to understand gaps in the location and capacity of infrastructure and services for industries outside of scope – notably those with niche waste streams, e.g. marine, health, construction & agriculture.
2. Strengthen the resilience and confidence in recovery supply chains and waste contractors that can assist in transitioning to the circular economy. This should include industry guidance to help businesses procure more effective, transparent and proactive waste contractors, and support for pretreatment and handling activities that streamline recycling supply chains.
3. Develop a priority list of streams involving waste management practices that do not involve landfill disposal (and avoid landfill levy costs), yet those practices inhibit higher value circular economy outcomes from being achieved. Prepare action plans to close off the use of those practices in cases where they displace solutions that more closely align with the waste hierarchy and that achieve higher value circular economy outcomes.
4. Develop a set of threshold questions / criteria and internal guidance for their application, to determine whether a proposed circular economy initiative genuinely represents a suitable recovery outcome that warrants support and encouragement, and enhances the social licence of the circular economy. Their application may need to involve some level of flexibility given the diverse range of initiatives that commercial leads may put forward.
5. Collaborate with EPA and other authorities (e.g. workers safety, emergency response) to develop a broader framework on a circular economy for controlled wastes (building on other individual actions mentioned in the report). This framework may aim to balance environment protection duties with incentives for innovation, while addressing areas of regulatory ambiguity that may otherwise contribute to deferred investment in solutions.
6. Implement a compositional audit program for 'general waste' generated by industries, where there is a lack of information on its constituent materials. The selection and design of categories, methods and timeframes for conducting audits should take into account specific details and features that are relevant to those participating industries.
7. Develop a set of standards of evidence and arguments necessary in making a funding allocation from the Waste and Resource Recovery Account, commensurate with the capital being applied to a given project or program (i.e. Circular Economy Investment Thesis or similar).
8. Actively weigh up and assess options to appoint high performing and productive engagement officers / organisations, to work with targeted industries in areas of greatest need and opportunity. Authorised engagement and delegation decisions should include review and evaluation mechanisms in line with sound governance principles.

Stakeholder engagement

In completing this project, businesses involved in ANZSIC Divisions A (Aquaculture only) through D were consulted with, along with industry bodies, regional waste authorities, chambers of commerce, regional economic growth agencies and the EPA. The project is indebted to the contribution of data, perspectives and other inputs that were offered by these organisations.

1 Introduction

The Waste and Resource Recovery Board (WRR Board) has requested a body of work that investigates, reports on and provides options in relation to the management of industrial waste in Tasmania, with a particular focus on waste generated in the northern Tasmanian region.

Delivered in response to this request, this project has a focus on industrial waste generated in the northern Tasmanian region, and how they can be better managed, taking into account Tasmania's scale, economy and the availability of relevant services across the state.

This public report incorporates findings from across the project. In fulfilling the WRR Board's request, it recommends activities for the WRR Board's consideration, to drive the improved management of industrial wastes across the state, including the management of priority waste streams. The report sets out an analysis of potential recovery pathways for priority industrial waste streams, and actions that may be needed to shift practices away from disposal and towards higher value, environmentally sound, recovery.

1.1 Scope of tasks

In general terms, the following tasks are core to the completion of this project.

1. Assess the status of industrial wastes arising from selected industries in Tasmania
2. Identify priority waste materials based on a prescribed set of characteristics
3. Set out and recommend options for improving the management of industrial waste.

1.2 Project deliverables

The following individual deliverables were required to complete the project and to signify the completion of major project milestones.

1. Draft report
2. Presentation to WRR Board and Departmental staff
3. Final project report, pending revisions based on feedback from the WRR Board.

1.3 Project context

Introduction of a waste levy and the sound reinvestment of funds

In 2022, the Tasmanian *Waste and Resource Recovery Act 2022* came into effect. This law enabled the collection of a statewide landfill levy to commence, helping to drive diversion of waste from landfill and provide funds to invest in improved waste management outcomes.

Understanding the status of all solid waste in Tasmania is essential for informing policy and strategic waste management investment. The WRR Board has identified the need to assess issues pertaining to the management of industrial waste in northern Tasmania, based on the preponderance of industrial activity in the north of the state and potential gaps in services for managing wastes from those activities.

This project is intended to build a profile of the locations, scale and nature of any gaps in the ability to manage industrial wastes to a higher standard, accounting for the characteristics of those streams. By extension, this understanding of gaps will inform the WRR Board's consideration of the types of intervention and investment that may be needed across Tasmania, and confirm areas where an active response is not adequately justified at the present time.

Definition of industrial wastes in scope and included ANZSIC Divisions

The *Australian standard for waste and resource recovery data and reporting* defines commercial and industrial waste as:[1]

> Waste that is produced by institutions and businesses, including offices, schools, restaurants, retail and wholesale businesses, and industries such as manufacturing. Also includes waste from primary and secondary production, such as mining and minerals processing.
>
> Encompasses waste from all Australia and New Zealand Standard Industrial Classification (ANZSIC) codes except Division E and Group 753.

The scope of this work is waste generated by the following industries as defined under ANZSIC:[2]

- Division A (Subdivision 02) – Aquaculture
- Division B – Mining
- Division C – Manufacturing
- Division D – Electricity, Gas, Water and Waste Services

The WRR Board requested that the scope focus on solid wastes that are inorganic. This may include organic streams that hold some inorganic content (e.g. timber treated with preservatives; sewage treatment biosolids with absorbed metals and/or synthetic compounds).

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[1] https://www.dcceew.gov.au/sites/default/files/documents/australian-standard-wrr-data-reporting-second-edition.pdf

[2] https://www.abs.gov.au/statistics/classifications/australian-and-new-zealand-standard-industrial-classification-anzsic/2006-revision-2-0/numbering-system-and-titles/division-subdivision-and-group-codes-and-titles

1.4 Project methods

Project delivered in two parts

The project was conceptualised and planned for completion in two stages, with the final report structured to represent findings from both Part 1 and Part 2 of the project.

Part 1 - Analysis of the status of industrial waste in Tasmania

This part involved setting up the project and building a profile of solid inorganic waste streams from Tasmanian businesses within the four stated ANZSIC industry divisions. Based on the streams' characteristics and an agreed set of criteria, the initial range of industrial wastes was reduced to a subset of priority streams, to be focused on during Part 2.

Part 2 – Options for improving management of industrial waste

The aim of this part of the project was to set out and recommend options for improving the management of those prioritised streams from the industries in scope. This exploration of options included the roles of different technologies in a Tasmanian commercial and regulatory environment, incorporating logistical and handling requirements and other activities to 'pretreat' some streams such that they can readily be processed by those technologies. This section of work additionally included activities for the WRR Board's consideration, to support the introduction of those technologies into the Tasmanian market.

1.5 Guidance note on interpreting findings from this project

This project was undertaken with the intent of understanding the different waste streams from businesses involved in activities associated with ANZSIC Industry Divisions A (aquaculture only) through D, and then putting forward solutions to achieve circular economy outcomes for a finite set of priority waste streams arising from those industries.

The project involved a broad scanning and engagement activity followed by a narrower dive into potential solutions. The inclusion of both areas of activity has led to some limitations in the time and resources that could be put towards stakeholder engagement, and towards exploring and validating different solution technologies and related supply chains. Moreover, efficient delivery of some solutions may come to rely on attracting waste streams from industries outside the scope of the project, which have not been consulted with inside this project.

The project team advises that stakeholder engagement needs to occur as an ongoing focus of activity beyond this project, to allow an ongoing check in on waste generating industries' interests, constraints and commitments towards circular economy outcomes. Further research that provides greater confidence in solutions within a Tasmanian context is also advised and put forward as a scope of activities for the WRR Board's consideration. The findings on technologies and solutions in this report may be confirmed, more precisely detailed, and/or revised based on a combination of these follow up research and engagement processes.

The report more generally puts forward a range of activity themes for the WRR Board's consideration, which is informed by challenges, gaps, and impediments to investment in circular economy solutions as have been identified during the project.

This project identified the need to link planning on regulatory reform and enforcement and public investments with efforts to build closer connections with industry. These connections should seek to align support with industries that genuinely commit to circular economy outcomes, and that are willing to deliver relevant material streams to solution providers that enter the Tasmanian market. Again, this may include industries that were not consulted with in completing the project (due to a combination of being out of scope, and a lack of response from attempts at engagement).

The actions set out in Chapters 5 and 6 have been prepared in isolation from other planning and decisions that the WRR Board may be progressing independently of this engagement, to which this project has had limited line of sight. The Board's efforts to implement any actions or recommendations are assumed to involve selection and checking for alignment with current *Waste and Resource Recovery Strategy* delivery and/or planning for future strategy iterations.

PART 1 – Prioritising industrial waste streams from ANZSIC Divisions A through D

2 General overview – industrial waste in Tasmania

To set the wider context for industrial waste generation in Tasmania, this chapter provides a sector level overview of commercial and industrial waste volumes, industrial waste source industries, and known existing destinations for industrial waste across the state.

2.1 Commercial and industrial waste and its destinations

According to NRE Tas' waste data website:[3]

- Total volume of commercial and industrial waste sent to landfill in 2023-24 was 130,720 tonnes
- Total volume of commercial and industrial waste sent to recovery facilities in 2023-24 was 293,960 tonnes.

The total amount of commercial and industrial waste that was generated and moved to a landfill or recovery facility in 2023-24 was 424,680 tonnes, such that an aggregate recovery rate of 69% was achieved. This figure is unlikely to include volumes generated and then stockpiled onsite, as this material has not passed through the gates of either a landfill or a resource recovery facility.

In publicly releasing these figures, NRE Tas clarifies the following:

> *'A Resource Recovery Facility is a facility or place where resource recovery takes place. Resource recovery is recycling, re-use, energy (or other resource) recovery or sorting or preparation for any of these activities. 21 "Class A" resource recovery facilities are currently reporting monthly waste data. These facilities each process over 10,000 tonnes of waste per year. "Class B" resource recovery facilities process between 1,000 and 10,000 tonnes per year and commenced reporting waste data on 1 July 2024.'*

The above figure for commercial and industrial waste recovery may be an underestimate, given volumes that may be recovered in smaller resource recovery facilities whose reporting commenced from 1 July 2024. On the other hand, if the reporting does not subtract residual volumes from reporting resource recovery facilities that are sent to landfill (e.g. due to contamination) from the recovery total, the figure may be a slight overestimate.

The estimates quoted above concern waste flows associated with commercial and industrial activities across the state. This project is more narrowly concerned with industrial wastes, specifically those arising from activities that fall within ANZSIC Divisions A through D, with Division A scope limited to aquaculture activities only. This represents a smaller, yet nonetheless unusually challenging, set of wastes within the commercial and industrial waste sector category.

[3] https://nre.tas.gov.au/environment/waste-and-resource-recovery/tasmanian-waste-and-resource-recovery-data

Controlled waste volumes generated in Tasmania

Some commercial and industrial waste types are regulated as controlled wastes by the Tasmanian Government, based on the risks posed to human health and environment and on the need to regulate interstate movements. NRE Tas provides a list of waste types on its website, including those types that are designated as hazardous wastes.[4] The categories used in this list are referenced in EPA guidance, legislation, and various statutory and non-statutory instruments to prevent and manage risks associated with different types of waste, although EPA also adopts the related term 'hazardous wastes' in line with the national waste classification system.

The NRE Tas website additionally presents data on hazardous waste volumes, which may be assumed to predominantly arise from commercial and industrial activities. In 2023-24:

- 37,690 tonnes of hazardous waste was sent to landfill
- 111,670 tonnes of hazardous waste was sent to recovery facilities.

In aggregate, the total hazardous waste volume generated in 2023-24 was 149,360 tonnes. Again, this figure is unlikely to include volumes generated and then stockpiled onsite.

From the above estimates, about 35% of the commercial and industrial waste generated and accounted for in Tasmania is categorised as hazardous waste. There is overlap between the scope of the present work and the range of wastes that are designated as hazardous, however the project scope is not limited to hazardous wastes but covers all types of solid inorganic waste generated in the ANZSIC Divisions included in this work.

2.2 Tasmanian industry profile based on licensed site analysis

An examination of permits issued by EPA Tasmania identified permitted premises as residing in the following industries that fall within ANZSIC Divisions A through D (Table 1).

Table 1: ANZSIC Divisions and corresponding industrial activities with a Tasmanian EPA permit (ListMap).

ANZSIC Division A	Aquaculture (hatcheries, farms, processing facilities, rendering facilities) NB: Fish farm animal feed manufacturing also included in this category for the purposes of this project.
ANZSIC Division B	Mining, ore and mineral extraction Quarrying, gravel and sand extraction and crushing
ANZSIC Division C	Metal processing / refining and smelting Chemical and advanced formulation manufacturing Engineered materials and products (for civil and mechanical applications) Beverage brewing Milk processing and dairy goods manufacturing facilities Wood, timber, pulp and paper goods manufacture and timber preservation Animal product processing (abattoirs, skin & hide processing, protein rendering) Other miscellaneous animal and plant product manufacturing (petfood, vegetable packing, confectionery, fibre goods production)
ANZSIC Division D	Energy production and supply (wind farms, power stations, LNG plant) Drinking water treatment and wastewater treatment plants Solid waste management, recycling and materials recovery activities.

[4] https://nre.tas.gov.au/Documents/Waste%20Material%20Classification%20Table.pdf

All of the above activities, listed as industry clusters (i.e. grouped according to their related commercial activities), fit within the scope of the project according to ANZSIC industry division. However, there is some blending across divisions (e.g. farmed fish processing is strictly a manufacturing activity (Division C), while fish farming itself falls in Division A).

Further, while a range of activities may technically be in scope, a majority of their solid waste streams may be organic in nature, and are of less relevance to the current project.

Project limitations – including finite resources and limited access to industry networks and literature – prevent a full investigation of all of the above-listed sectors, and the project will therefore focus on those carrying a combination of the following pragmatic features:

- Industries where there are likely to be sizeable volumes of solid, inorganic industrial wastes that are not being commercially recovered in significant quantities, and/or where the waste generator is facing challenges in identifying practical, affordable and low environmental impact solutions for their solid, inorganic industrial waste streams.
- Waste generation literature is available (e.g. through public Annual Environmental Reviews, or other corporate documents and online content).
- Stakeholder engagement has been effective in securing access to information not otherwise available.

Other site-based commercial activities that are not licensed and are out of scope

The list above does not include non-licensed commercial activities such as retail and wholesale trade, pastoralism, cropping, forestry, commercial garden and landscape development and maintenance, logistics and transport, health services, education services, various professional services, hospitality and tourism, public administration, etc.

A large fraction of commercial and industrial waste volumes may arise from these non-licensed activities such that they make a large contribution to the 425,000 tonnes of C&I waste generated in Tasmania. However in most cases, the vast majority of their waste volumes (apart from tyres, clinical and hazardous chemical wastes, for example) may be managed through facilities that handle general or inert waste, commingled recycling, and food and garden organic waste streams. They are of less concern to this project, as they are not likely to directly compete for resource recovery capacity that targets the more challenging waste streams from the industries that are in scope.

Site-based manufacturing activities that are not licensed yet are in scope

There may also be significant levels of waste from non-licensed manufacturing (e.g. smaller breweries and dairy goods producers, distilleries, boatbuilding, niche mechanical engineering and metal working, niche plastic products manufacturing), which may be relevant to the project as ANZSIC Division C industries, but are not visible via EPA permit datasets.

The fact that these do not require a permit suggests that their waste streams (at the individual site level) have not historically been viewed as a major concern by the EPA. While the project team was open to collecting data on these industries' waste streams on an incidental basis, engagement and literature review activities provided limited opportunity to note waste streams from these sectors. The Tasmanian Government may opt to conduct a future project that delves into more detail in selected sector waste streams.

Project related works that do not fall into the EPA site permit regime

Further, some large scale commercial activities may involve large civil projects that occupy a landscape for a limited and defined period of time (e.g. major infrastructure builds and site decommissioning activities) and which do not have permits available for download via ListMap. Nonetheless their activity may involve production of hazardous materials (e.g. contaminated soils, sludges and slurries; contaminated building materials and aggregates; end of life equipment) that nonetheless form an industrial waste stream that requires specialised management and disposal methods (distinct from non-hazardous construction and demolition wastes).

A similar observation may be made for distributed infrastructure systems that are not licensed (e.g. electricity transmission and distribution networks, drinking water and sewage networks), whose maintenance, expansion and/or decommissioning also generate industrial waste.

These streams will be examined in this project, to the extent that they fall within ANZSIC Division D activities (covering the operations of water, gas, electricity and waste utilities), and based on concerns raised by relevant stakeholders.

2.3 Facilities that accept industrial wastes

A range of facilities are able to accept solid industrial wastes for disposal and/or resource recovery across Tasmania, including hazardous and non-hazardous streams. Less hazardous streams may be accepted in more general purpose facilities including general waste landfills and materials recovery facilities (MRFs), whereas the risks associated with other industrial wastes dictate the need to use facilities that are specifically permitted to accept prescribed categories of hazardous waste.

Table 2 below may not be exhaustive but nonetheless sets out some of the facilities that may take industrial wastes from ANZSIC Divisions A (aquaculture only) through D. Detail is also provided in terms of their permitted capacity and waste types.

This list does not include facilities and premises that are predominantly used to dispose of or recover organic streams such as composting facilities and parcels of land used for land spreading practices. It also does not include smaller or more niche disposal premises, such as limited disposal areas designated on mine sites (for mine waste generated onsite) and quarry pits that take modest amounts of inert waste. MRFs which are predominantly set up to recover resources from kerbside / municipal recycling are not listed, but may take a quantity of recyclables from commercial sources that resemble the items found in kerbside recycling bins.

Some waste types that are permitted to be received by some landfills have been abridged for brevity (e.g. descriptions of medical sharps, sanitary waste) compared to the permit documents. Because this content is derived from documents downloaded from ListMap, there may be more recent developments (e.g. closures, revised operations) that have not been captured.[5]

[5] https://maps.thelist.tas.gov.au/listmap/app/list/map

Table 2: An indicative list of landfill and resource recovery facilities that take commercial and industrial streams, including streams from activities within ANZSIC Divisions A through D.

Facility	Permitted industrial wastes included general and controlled
Copping landfill Category B Cell Located in Sorell Council Permitted capacity: 200,000tpa	Permitted to accept general wastes including: Inert waste, clean fill, putrescible waste, class 1 and class 2 biosolids, quarantine waste Permitted to accept controlled wastes restricted to: Asbestos waste, scrap tyres, medical sharps, sanitary waste, animal effluent & residues, fish morts from finfish farming, spadable sewage sludge, low level contaminated soil
Copping landfill Category C Cell Located in Sorell Council Permitted capacity: 45,000tpa	Permitted to accept general wastes including: Inert waste, clean fill Permitted to accept controlled wastes restricted to: Asbestos waste, scrap tyres, medical sharps, sanitary waste, animal effluent & residues, spadable sewage sludge, low level contaminated soil, batteries, waste oil
Dulverton Waste Management landfill Located in Latrobe Council Permitted capacity: 80,000tpa	Permitted to accept general wastes including: Inert waste, clean fill, putrescible waste Permitted to accept controlled wastes restricted to: Asbestos waste, scrap tyres, spadable sewage sludge, animal effluent & residues, sanitary waste, low level contaminated soil, batteries, waste oil
Dulverton Waste Management salt waste mono-cell Located in Latrobe Council Permitted capacity: 3,500t total	Permitted to accept salt cake containing elevated levels of salt and fluoride, up to a volume of 3,500 tonnes in total. This permit was issued in 2016, and is understood to be granted for a one-off disposal.
Launceston Waste Centre landfill Located in Launceston City Council Permitted capacity: 150,000tpa	Permitted to accept general wastes including: Inert waste, clean fill, putrescible waste, green waste, medical sharps, sanitary waste Permitted to accept controlled wastes restricted to: Asbestos waste, scrap tyres, animal effluent & residues, batteries, waste oil, animal carcasses, low level contaminated soil
Heybridge landfill Located in Burnie City Council Permitted capacity: 50,000tpa	Permitted to accept general wastes including: Inert waste, clean fill, clarifier sludge, silica sand
Zeehan landfill Located in West Coast Council Permitted capacity: 8,500tpa	Permitted to accept general wastes including: Inert waste, clean fill, putrescible waste, green waste, medical sharps, sanitary waste Permitted to accept controlled wastes restricted to: Whole and macerated fish, low level contaminated soil, asbestos waste, scrap tyres, non-liquid animal effluent and residues, batteries, spadable sewage sludge, waste oil
Recycal scrap metal recycler Located in Launceston Council Permitted capacity: 60,000tpa	Permitted to accept: Scrap metal for recycling, scrap tyres, used lead acid batteries, cars, car parts, drums, motors, whitegoods, HVAC systems and components, hot water systems and components, furniture containing metal, and scrap metal with non-metallic

Facility	Permitted industrial wastes included general and controlled
	components fixed to it such as foam, fabric and plastics or any such-like recyclable items
Sims Metal scrap metal recycler Located in Launceston Council Permitted capacity: 70,000tpa	Permitted to accept scrap metal for recycling
Tasmania Oil Located in Burnie City Council Permitted capacity unstated	Has been granted an Environment Protection Notice (EPN) allowing their acceptance of waste oil, pending a full assessment of their activities and the possible issuance of a permit.
Hagen Oil Located in Launceston Council Permitted capacity: 3,000tpa	Permitted to accept waste oil
Tyrecycle Located in Brighton Council Permitted capacity: 5,000tpa	Permitted waste streams unspecified but assumed to cover scrap tyres.
Cement Australia Located in Kentish Council Permitted capacity: see hourly input approvals (as tph)	Permitted to accept as approved fuels: High viscosity fuel, no more than 5tph Spent Cell Liner, no more than 1.5tph Spent Fluid Cracking Catalyst, no more than 1tph Spent Fuel Cracking Catalyst, no more than 1tph

Following the terms used in EPA permits, the waste types that may be accepted at landfills are separated into general waste and controlled waste. EPA defines controlled wastes as follows:[6]

> *'Controlled waste is the most hazardous category of waste and includes those wastes that exhibit toxicity, chemical or biological reactivity, environmental persistence, or the ability to bio-accumulate or enter the food chain. These wastes need to be carefully managed and are closely regulated because of their potential to adversely impact human health and the environment. Some controlled wastes, such as tyres, are not strictly hazardous but they may also need special management.'*

Individual controlled waste generation, transport, handling and recovery activities may refer to one or more controlled waste codes published by EPA.[7]

Larger capacity landfill facilities have broad similarities with respect to their permitted general waste and controlled waste streams. However, their permits all provide for the acceptance of other wastes (including controlled wastes) if approved by the EPA Director. At present, the project team has no visibility on what streams have been approved by the EPA Director, separate to those listed in publicly available documents as presented in the table below.

In all likelihood, these approval processes have made use of the higher standard of controls placed on Copping landfill B-cell and C-cell compared to other landfills that take wastes that

[6] https://epa.tas.gov.au/business-industry/regulation/waste-management/controlled-waste
[7] https://epa.tas.gov.au/business-industry/regulation/waste-management/controlled-waste/controlled-waste-category-codes

carry low levels of environmental risk. These approvals would then allow for the disposal of higher risk industrial waste streams at the Copping facility, while other facilities that are built to a lower standard and with lower control systems in place may be restricted in terms of the industrial wastes that they can accept.

Contaminated soils and *EPA Information Bulletin 105*

EPA Information Bulletin 105 – Classification and Management of Contaminated Soil for Disposal defines the criteria used by the EPA for classifying contaminated soil that requires treatment and/or off-site disposal, and sets out the legally compliant management of each classification.

The bulletin sets out categories of contaminated soil (Table 3), which may also apply to other industrial waste streams, as mentioned above. A clear distinction between categories is that Level 4 contaminated soil requires remediation prior to landfill disposal. Level 3 contaminated soil may only be disposed of in a Category C landfill cell, while Level 2 contaminated soil (so-called 'low level contaminated soil') can be accepted at a Category B landfill cell.

At present, there is only one Category C landfill cell in Tasmania, located east of Hobart and operated by Southern Waste Solutions (generally referred to as 'Copping C cell'). Other landfills including Dulverton Waste Management, Launceston Waste Centre and other smaller regional landfills have the necessary permit conditions to accept Level 2 contaminated soil and Level 1 contaminated soil only.

Table 3: Categories of contaminated soil as set out in *EPA Information Bulletin 105*, including descriptions and additional EPA comments.

Category	Description	Additional EPA comments
Fill material Level 1 Contaminated soil Not controlled waste	Soil that exhibits levels of contaminants below the limits defined under *Fill Material* in Table 2 in *EPA Information Bulletin 105*.	Soil classified as Fill Material can still be a 'pollutant' under the *Environmental Management and Pollution Control Act 1994* and needs to be responsibly managed.
Low level contaminated soil Level 2 Contaminated soil Likely to be controlled waste	Soil that exhibits levels of contaminants above the limits defined under Fill Material but below the limits defined under Low Level Contaminated Soil in Table 2 in *EPA Information Bulletin 105*.	Where leachable concentrations have not been prescribed, maximum total concentrations will be used to classify the soil.
Level 3 contaminated soil Is a controlled waste	Soil that exhibits levels of contaminants above the limits defined under Low Level Contaminated Soil but below the limits defined under Contaminated Soil in Table 2 in *EPA Information Bulletin 105*.	Where leachable concentrations have not been prescribed, maximum total concentrations will be used to classify the soil.
Level 4 contaminated soil Is a controlled waste Requires remediation prior to disposal	Soil that exhibits levels of contaminants above the limits defined under Contaminated Soil in Table 2 is generally not considered acceptable for off-site disposal without prior treatment.	Soil that contains contaminants that do not have criteria for leachable concentrations (e.g. petroleum hydrocarbons), and the levels of contaminants exceed the maximum total concentrations listed in Contaminated Soil, are generally classified as Contaminated Soil for Remediation.

Application of *EPA Information Bulletin 105* to industrial wastes other than soil

While the information bulletin was prepared to guide the management and disposal of contaminated soil, its guidance may be applicable to the classification of other solid waste material on an 'as needs basis.'

For industrial wastes that are not contaminated soils, it is anticipated that landfill operators may be reluctant to accept any streams whose contaminant loading exceeds the contaminant loading for contaminated soils that they are permitted to accept (i.e. they are anticipated to apply the same standards to other industrial wastes). This has been confirmed through stakeholder engagement.

For landfills that are able to take Level 3 contaminated soil, the bulletin advises that it is at the landfill operator's discretion as to whether or not they will accept the waste. In the current market environment, this means that the operators of Copping landfill decide whether or not they are willing to accept Level 3 contaminated soils and 'equivalent' non-soil industrial waste streams. They cannot be compelled by the waste generator or by other parties.

Use of Level 2 contaminated soil as landfill daily cover

The bulletin advises that Level 2 contaminated soil may, in some cases, be suitable for disposal as intermediate landfill cover at nominated municipal landfills. It advises that the landfill operator should refuse the use of soil as daily cover, if that soil has not been classified and approved, and if there is likelihood that acceptance of the material may result in a breach of the landfill operator's permit conditions. Presumably, this same guidance applies for non-soil industrial wastes whose contaminant loading is equivalent to that of Level 2 contaminated soil.

The implication of this guidance is that industrial waste generators are not in a position to demand or compel landfill operators to accept their wastes as daily cover, in the absence of adequate testing and approval as set out in *EPA Information Bulletin 105*.

3 Industrial waste profiles by ANZSIC Division

3.1 ANZSIC Division A – Aquaculture

The aquaculture industry in Tasmania is dominated by salmonid (salmon and trout production, at about 83,000 tonnes annual production).[8] According to the Tasmanian Government, industry value is broken down as follows (gross catch value), revealing the vast majority of economic value as arising from salmonids (salmon and trout) farming and related value-adding activities:

- Salmonids $1,014m
- Rock lobster and crab $58m
- Abalone $53m
- Oysters $35m
- Other $24m

In general terms, the farmed salmon and trout industry cluster is composed of fish hatcheries; fish farms; fish processing facilities; fish byproduct rendering and ensilage facilities; and aquaculture feed production facilities.

The following paragraphs summarise project findings on wastes generated across the supply chain for farmed salmon and trout (salmonids), based on a review of individual business reports (sustainability reports, annual reports); information on company websites; descriptions provided in EPA-mandated Annual Environmental Reviews (AERs); and other non-confidential sources.

Despite an attempt to engage with the industry via Salmon Tasmania, the team was unable to hold interviews with industry representatives. The findings presented below have therefore not been confirmed or updated with stakeholder input. The WRR Board may want to engage with industry representatives to confirm priorities and to ascertain their commitment to improved circular economy outcomes for waste streams prioritised in this project.

Findings on major Aquaculture waste streams

Across the supply chain for salmon and trout farms (the dominant subsectors of the Tasmanian aquaculture industry), there are several groupings of waste. Due to the core activities of the sector, large quantities of organic waste are generated in the form of salmon feed production waste; effluent sludge; inadvertent fish mortalities; and frames, viscera, and offcuts. These organic streams collectively form the majority of aquaculture waste, and go through a range of recovery steps including land spreading, composting, and diversion to pet food manufacture. This may involve intermediate stabilisation at a rendering plant.

The operation of fish farms appears to generate substantial volumes of equipment waste, which involves a range of plastics. While progress has been made to use and recover recyclable plastics such as HDPE, engagement with the landfills sector suggests that ropes and flotation equipment are perhaps not being recovered to the same extent as other equipment and consumables.

Fish processing facilities generate a range of inorganic waste streams associated with processing, packaging and distribution. While a large majority of categories of packaging and

[8] https://www.cg.tas.gov.au/__data/assets/pdf_file/0010/397135/Tasmania_Delivers_-_Aquaculture.pdf

distribution waste are reused or recycled, some specific streams are nonetheless sent to landfill. This includes thin plastic film which is contaminated with fish residue, which established recyclers are unwilling to accept. The data on the reuse and recycling of packaging used for industrial inputs, such as bulk bags and plastic bins, has some gaps – there may be opportunity to lift the recovery of these materials.

Hatcheries, processing facilities, fish waste rendering facilities and fish farm feed manufacturers all seem to generate substantial amounts of 'general waste' which is sent to landfill, and which may not have been compositionally profiled via audits or similar. Perhaps several hundred (300 to 500 tonnes) of general waste may arise from the sector each year.

There may be merit in understanding these streams in more detail, and separating out individual streams for reuse or recovery. In particular, AERs and other sources did not appear to mention a range of materials – end of life equipment, e-waste, used PPE and similar – that may be embedded within the general waste category and may be suitable for recovery.

To sum up, streams that may have a prospect of greater recovery across the aquaculture (farmed salmon and trout) supply chain include:

- Plastic ropes and flotation equipment
- Some forms of industrial and distribution packaging such as bulk bags, rigid plastic bins, and thin plastic film – mainly used in fish processing facilities
- Streams within the 'general waste' category that are not well understood, spread across the farmed salmon and trout supply chain.

The literature indicates that this sector has been proactive in addressing its inorganic waste streams – most notably those that are made of plastic – and may prove to be willing partners in future plastics circular economy initiatives.

Overview of major aquaculture waste streams and fates

Figure 1 overleaf provides an overview of the main waste streams associated with the supply chain for aquaculture produce, using farmed salmonids as an example given the dominance of that industry segment. This diagram is based on a review of publicly available literature – engagement with the industry may give rise to the need for amendment.

Particular attention may be drawn to the plastic streams used in fish farms themselves, as it is understood that the aquaculture industry has been allocating considerable effort to recycle more fish farm plastics. The actual disposal and recycling destinations of these waste streams may therefore be going through a transition period.

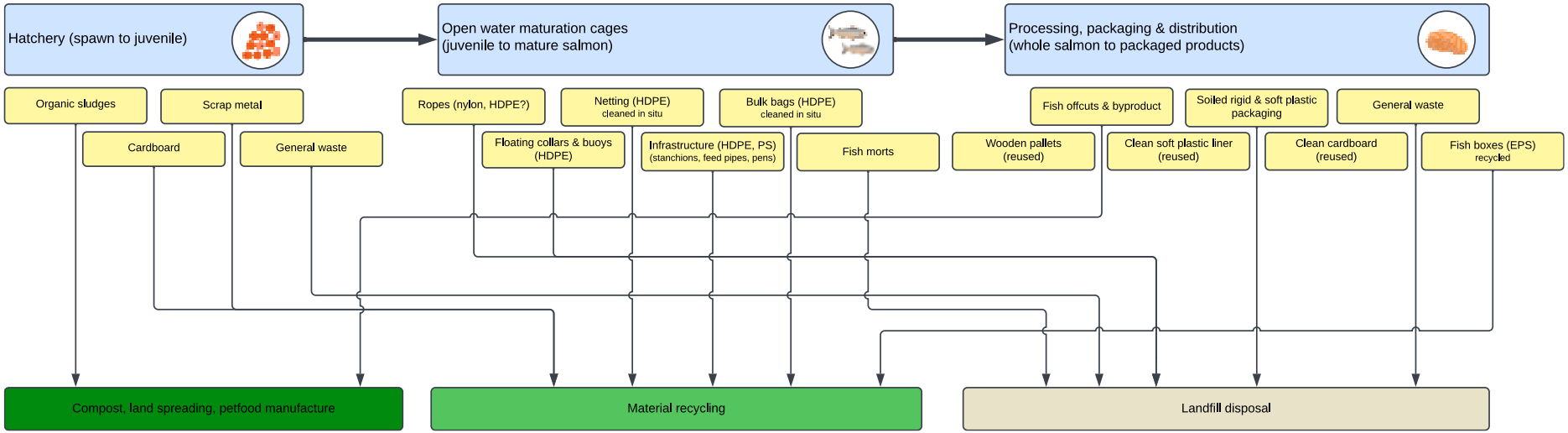

Figure 1: Overview of major aquaculture key waste streams and fates (using farmed salmonids as an example).

3.2 ANZSIC Division B – Mining

While the Tasmania mining sector operates at a smaller scale than in mainland states that have a large land mass and immense reserves of commercially valuable minerals, the sector is nonetheless an important contributor to the Tasmanian economy. The Tasmanian Government identifies several major mining operations that are currently active and span iron ore, tin, lead, zinc, silver, gold and coal extraction.[9]

For the purposes of this project, the activities in this section span operations involved in mining, as well as initial beneficiation activities such as crushing, separation and handling to allow the primary mineral to be value added elsewhere. It does not include refinement and processing into metal commodities and more advanced materials.

Each mine will have its own waste generation profile, according to the minerals and surrounding geography, extraction requirements, and the technologies and methods particular to the operation. However, in broad terms, the streams may be generally categorised as:

- Geological and process waste, which involves various bulk solid and liquid waste which are, in essence, the unwanted and/or lower value materials that are left behind after extracting commodity grade minerals from the total volume, using physical and chemical processing techniques. This may include, for example, waste rock, tailings (which may contain a range of physical and chemical separation additives), overburden etc.
- Other waste, which includes materials other than the lower value residuals left over from the ore body and surrounding earth and the mass left over from physical and chemical separation activity. This may include end of life equipment and consumables; decommissioned plant; spent chemicals; safety gear etc. These waste streams may be hazardous or non-hazardous, depending on their exposure to industrial chemicals and mining products, and this may influence their handling, storage, treatment, disposal and recycling requirements.

The paragraphs below summarise key findings on mining waste types and their management paths, noting that descriptions are generalised across mining operations in Tasmania, according to information available from environmental permits, AERs, and public information on company websites and sustainability reports. A number of mining companies shared their current waste management focus areas during interviews for this project, and general lessons may be read from their input with caution. There may be some general patterns in how certain streams are dealt with, although individual mines may depart from those practices to varying degrees.

In terms of waste volume, each waste stream's quantity will be highly dependent on the stage of mine operation, the scale of production, and the operations and practices that occur on the mine at a given point in time. However, as a general rule, the volume of geological and process waste greatly surpasses the volume of other waste stream, during the active phase of mineral extraction. This may reverse during decommissioning and caretaker phases of the site, in which waste disposal activities will be guided by an approved closure and rehabilitation plan.

[9] https://www.mrt.tas.gov.au/mining

Findings on major Mining sector waste streams

Mines across Tasmania generate a number of industry specific waste streams, which may generally be grouped into geological and process waste; and non-process waste. The former includes hazardous and non-hazardous bulk materials extracted from the mine site and/or generated as a large volume byproduct from initial beneficiation activities. The standard practice for these materials is to manage the waste onsite.

This management may variously involve use in rehabilitation, backfilling and stabilising underground voids, or potentially left in piles as mine spoil heaps over a temporary or more indefinite period. More hazardous materials such as tailings may be treated or separated from the surrounding environment using engineered containment zones.

It may be physically impractical and commercially unviable to recover large volumes of inert geological material given long distances to market, and competition from local businesses that produce and sell sand, gravel, rock and stone aggregate. There are significant risks in moving very large volumes of more hazardous process waste offsite to recovery and/or treatment facilities that are further afield. The preferred approach may be to treat or contain onsite as necessary, while enabling the extraction of any residual resources at a future point.

Non-process waste generated by mines involves a wider miscellany of waste materials such as end of life equipment and consumables, and the various streams associated with industrial workforces (packaging, e-waste, PPE etc.). Some of these streams may be hazardous due to the presence of heavy metals (e.g. lead, cadmium) or mining industry chemicals (e.g. fluorides, cyanides, sulfuric acid, various hydrocarbons and lubricants).

At present, the non-processing waste streams that are hazardous due to heavy metal or industrial chemical contamination, are either disposed of onsite or in offsite landfills. The one identified exception to this pattern is oil and grease impregnated materials which appear to be sent to hydrocarbon and oil recovery specialists. The presence of hazardous contaminants should not preclude their recovery where they are composed of valuable materials, although recovery will need to include one or more decontamination steps which may impact commercial viability.

Among the non-processing streams generated by mines, multiple streams of general commercial wastes (not described in further detail) and commercial recyclables (timber, scrap metal, paper, cardboard, and the aforementioned hydrocarbon and oil contaminated streams) occur in significant volume. Those that are practical to recycle are being recycled through third party commercial waste contractors, although there may be streams in the general waste category that could be recycled by more niche services. There are also some instances (anecdotally reported) of onsite landfills being used to dispose of recoverable materials (electrical conduit, poly pipe), due to the low cost and convenience of this solution.

A range of items composed of rubber (with other materials) are produced by mines, including tyres, conveyor belts, mill liner, vehicle tracks, and hosing. These items are typically stockpiled or buried onsite, yet there are examples of smaller diameter underground mine tyres being recycled via facilities in mainland Australia. Industry engagement suggests an openness towards recovering resources from these items, if a viable and legitimate solution can be identified.

The practice of stockpiling rubber waste onsite reflects a degree of uncertainty in the future direction for regulating mining tyre disposal, as it enables the operator to dispose onsite or recover according to future circumstances and compliance expectations. However, in the meantime, large stockpiles may present a significant fire risk and this may warrant the need for a more immediate and permanent solution for tyre wastes across the industry.

Overview of mining waste streams and fates

Figure 2 overleaf provides an overview of the main waste streams associated with mining as it takes place in Tasmania, based on a review of literature and engagement with a subset of mining companies involved in open cut and underground mining. The diagram therefore provides a picture that has had some limited verification with stakeholders. Individual mining companies that did not participate in engagement may have practices that depart from those shown.

It may be noted that, while there is reasonable confidence that some recyclable streams are largely being recycled throughout the sector, some recyclables may be involved with multiple fates including recycling and onsite accumulation. For those materials being accumulated onsite, a pre-emptive determination cannot be made as to whether they will eventually be recycled or discarded as waste.

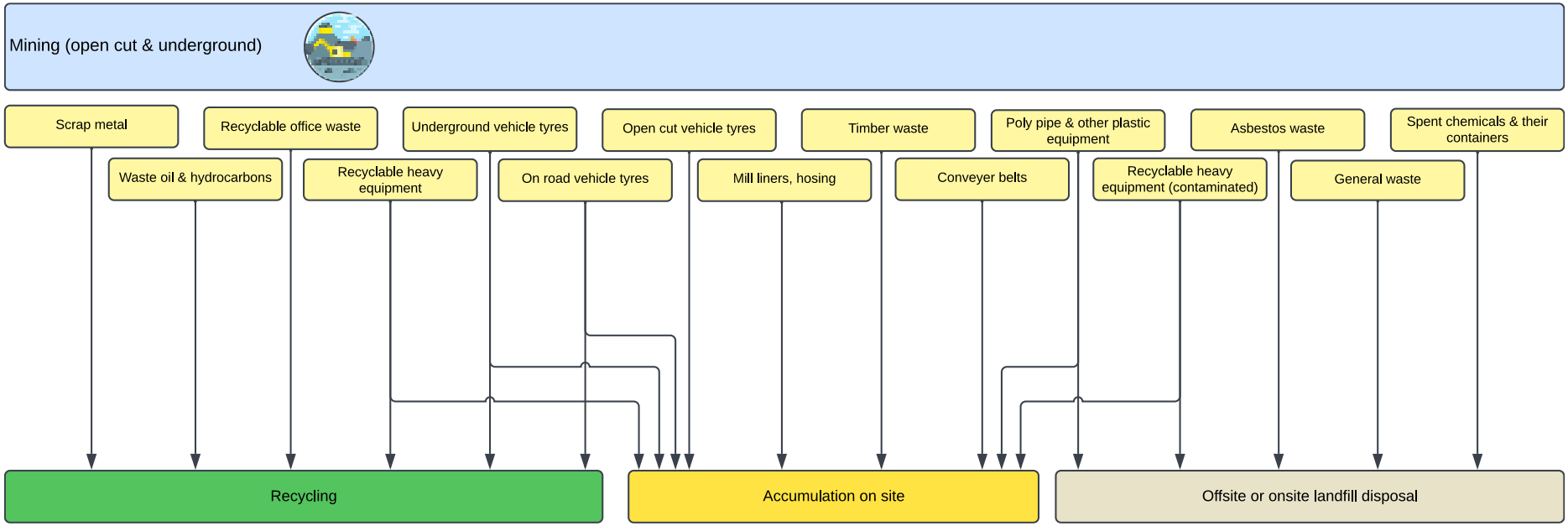

Figure 2: Overview of mining waste streams and fates.

3.3 ANZSIC Division C – Manufacturing

Manufacturing covers a wide range of commercial activities across Tasmania, which make use of one or more of the state's competitive advantages in renewable energy, primary industry, and skilled workforces and business acumen. According to ABS, the ANZSIC Division for manufacturing includes 'units mainly engaged in the physical or chemical transformation of materials, substances or components into new products (except agriculture and construction).'

While this division is broad in principle, the reality is that medium to larger scale manufacturing in Tasmania takes place in a limited subset of sectors, as is the case with all locations with a mixed economy with competitive advantages in a finite set of areas. A review of the EPA's environmental permits indicates that Tasmanian manufacturers are active in the following industries that require a level of environmental approval:

- Animal product processing (abattoirs, skin / hide processing, protein rendering facilities)
- Alcoholic beverage breweries (and distilleries)
- Milk processing and dairy goods manufacturing facilities
- Wood, timber, pulp and paper goods manufacture and timber preservation
- Other miscellaneous animal and plant product manufacturing (petfood, vegetable packing, confectionery, fibre goods production)
- Quarrying and extracting sand, gravel and aggregate rock and stone, and crushing to size for a range of civil applications
- Mineral processing, refining, smelting and casting to produce metal commodity products
- The manufacturing of advanced chemicals and formulations for various industries
- Advanced engineered materials and products fabrication and assembly, involving e.g. metals, plastics, fibreglass and other composites to produce a range of goods.

Other manufacturing may occur in Tasmania without needing an environmental approval. In this project, a subset of manufacturing activities present in Tasmania was explored, with a focus on the waste products arising from those activities. These industries include:

- Metal product manufacturing including advanced metal-based materials and minerals processing
- Advanced industrial chemicals and therapeutics
- Food production
- Cement manufacturing
- Timber products manufacturing.

This covers a limited subset of Tasmanian manufacturers, given the impracticality of an exhaustive study within the limitations of the current project. Nonetheless, findings from these selected industries may be informative in terms of the broader implications for solid inorganic industrial wastes arising from Tasmania's manufacturing base. The main findings from this study are set out below, following a review of public AER documents and engagement with available stakeholders.

Findings on major Manufacturing sector waste streams

The manufacturing sector is diverse and includes a number of activities that fall inside ANZSIC Division C. While it is impractical to study and engage with all industries for this project, a subset of industries was explored, including those manufacturing: metal commodities; advanced chemicals and therapeutic goods; food and dairy goods; cement; and timber products. Interviews took place with metals, timber products and cement industries.

Northern Tasmanian metal production and processing is concentrated in the Bell Bay Advanced Manufacturing Zone. An exploration of sites in the zone suggests that there are some sizeable stockpiles of silicon-manganese slag (up to 100,000 tonnes), and other industrial byproducts associated with smelting accumulated over the long term, which do not yet have a sustainable waste management solution in place. The parties liable for these stockpiles have not, as yet, opted to have these materials disposed as a waste stream in an offsite landfill facility.

The metal production sector generates ongoing quantities of heavy duty plant and equipment (e.g. degraded electrodes) which are irreparably damaged or worn in the course of their normal operating conditions. The sector has had success in finding recycling solutions for these materials, yet some heavy duty equipment waste streams may pose an ongoing challenge.

The chemicals and therapeutic goods sector reports on hazardous and controlled wastes and their destinations, with regulation and risk management drivers variously calling for deep burial disposal and/or disposal in a hazardous waste landfill cell as suitable. More benign organic streams are recovered via composting or land spreading. There is less detail on other forms of waste, as they are reported on as 'general waste' and various forms of recycling.

As may be expected, the food and dairy sectors generate organic waste streams that are land spread, composted or are packaged and sold as soil additives without further processing. Other categories of waste include various forms of industrial packaging which, according to AERs, are being recycled via commercial contractors. A significant fraction of the total waste generated in this sector is 'general waste' sent to landfill without further characterisation.

The cement industry centres on a kiln adjacent to Railton in the Kentish Council locality. The cement kiln has a major role in industrial waste recovery and takes several feedstocks as alternative fuels, including: aluminium smelter spent cell lining; high viscosity fuel (originating from various mainland sources that are blended in a plant in Melbourne); and spent catalysts (from hydrocarbon refineries in Victoria). It has also used waste alumina and refractory brick as an industrial input. In the near term, it plans to take shredded passenger car tyres and forest residue to lift its use of alternative fuels from 17% to 50% of its energy needs.

In the timber products sector, most streams are being recycled or recovered for energy – including bark and woodchip waste; bark and grit scrapings from log yards; scrap metal; and oil and hydrocarbon waste. There has been interest in the conversion of bark and woodchip waste to biochar for a range of energy and smelting applications (yet to undergo development). At present, boiler ash produced in powering drying kilns may be disposed of but has also been used as a fertiliser input. The sector has voiced an interest in finding other uses for this boiler ash.

In summary, the manufacturing sector involves a spread of waste streams that are being recycled or disposed of. There are evident opportunities to improve the recycling outcomes for metal processing byproducts and worn heavy duty equipment; timber sector boiler ash; and potentially sub-streams within the 'general waste' category of industrial waste streams.

As a general finding, solid wastes implicated in manufacturing may include the following, to varying degrees and dependent on the sector in question:

- Surplus and off specification raw materials and/or products
- Processing byproducts, i.e. unwanted, low value materials that are not the intended product during the production of one or more commercially useful goods
- Degraded or contaminated inputs ('spent' inputs)
- End of life equipment including machinery, tools, office furniture, electrical and electronic equipment and consumable items
- Packaging waste, including packaging that may contain hazardous material residues
- Waste streams arising from pollution controls (filter cakes, sludges, baghouse dust etc.)
- Workforce related waste streams – e.g. food and catering waste, uniforms, PPE, hygiene wear and other specialised clothing (both single use and reusable), etc.
- Waste streams generated during industrial accidents or incidents (spills, fire etc.) such as used rags, booms, sand and other absorbent materials, and damaged plant, equipment and inventory.

These general categories may be useful for the WRR Board, should it be interested in exploring circular economy opportunities in other manufacturing sectors that were not included in this project due to a lack of supporting information.

Figure 3: Cement Australia operation at Railton. Cement Australia has been successful in using a range of recovered inputs in its operation, including high viscosity fuels, spent cell liner, and spent catalyst. Cement Australia has also received finding to upgrade its plant to accept tyre derived fuels and forest residues as alternative energy sources.

Overview of example manufacturing waste streams and fates

Figure 4 provides an overview of the main waste streams associated with two sectors within manufacturing – metal smelting and processing; and timber products manufacturing. These were selected to represent through visual description, based on their complex set of industry-specific waste streams and because industry representatives were able to verify relevant particulars.

The section on the left covering metal smelting and processing shows that a range of materials are being recycled. However, the sector also generates some process-specific waste streams in large volumes – byproducts that vary in physical and chemical composition and heavy equipment – that do not always have clear and obvious options for recovery. Some of these materials are being recycled, while some are being accumulated onsite in large quantities or are being disposed of in suitably engineered landfill cells. These streams may present appealing prospects for recycling, although they may need to involve innovative solutions rather than relying on conventional, general purpose recycling supply chains and markets.

A range of waste streams are also produced by the timber preservation and products manufacturing sector, although a number of them are largely organic (and therefore out of scope for this project) and many are being recycled or passed on to other industries such as paper manufacturing and landscaping industries. Timber product industry representatives mentioned that the boiler ash from their timber kilns was currently being recycled through blending into fertiliser / soil additive mixtures, and expressed the view that this was a somewhat low grade recycling outcome compared to others that may prove to be viable.

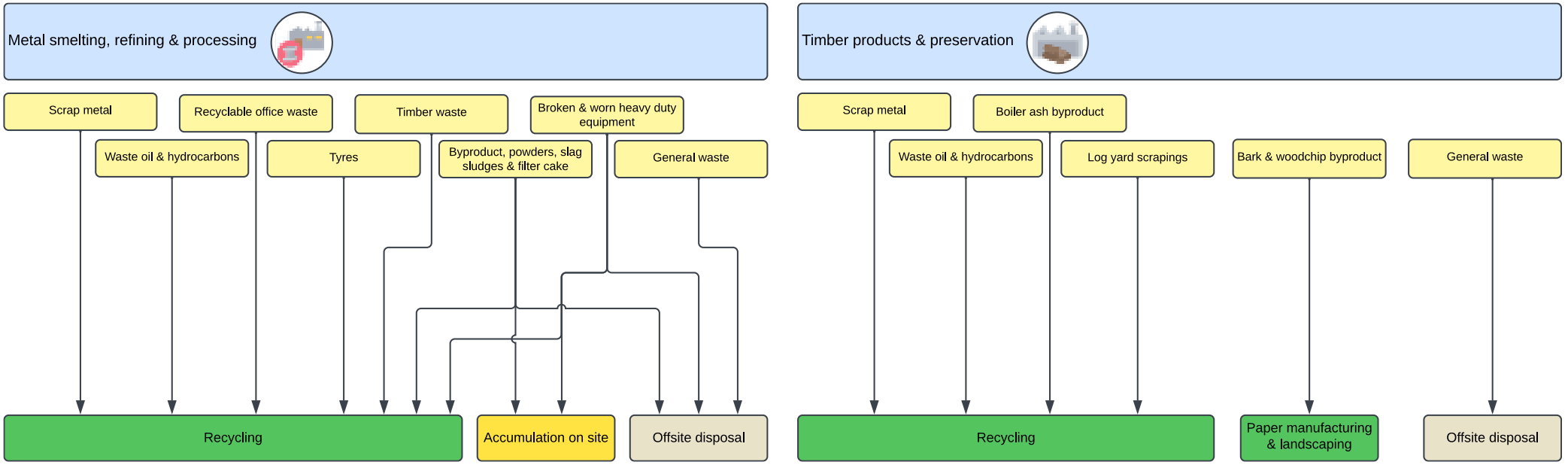

Figure 4: Overview of the main waste streams associated with two sectors within manufacturing – metal smelting and processing, and timber products manufacturing.

3.4 ANZSIC Division D – Electricity, gas, water and waste services

According to ABS, ANZSIC Division D includes electricity, gas, water and waste services, and comprises economic units engaged in the provision of:

- Electricity, including generation and transmission and distribution (as delivered by HydroTasmania, TasNetworks and other parties)
- Gas supply via the gas mains system (as delivered by TasNetworks)
- Water services including drinking water and wastewater treatment, and the management of storage, drainage and sewage networks (as delivered by TasWater)
- Services in the collection, treatment and disposal of waste materials, remediation of contaminated materials, and the recovery of materials from the waste stream (as delivered by local councils and commercial waste sector businesses).

These utilities are delivered through a combination of government owned enterprises, local councils and private businesses. Their solid waste streams include materials that are generated at larger facilities, as well as volumes produced at smaller properties that, although dispersed across the state, nonetheless comprise significant quantities of industrial waste.

During the project, the team was able to engage with HydroTasmania and a privately owned power company, TasWater, and metal recycling and landfill businesses. This has allowed some coverage of ANZSIC Division D, although it presents gaps in knowledge in regard to electricity network and gas network waste. It may also be acknowledged that the waste and recycling sector is quite diverse in its own right, and there may be some complex and challenging byproducts from recycling that this project did not come across due to engagement limitations.

Findings on major Water, Energy & Waste sector waste streams

A range of solid inorganic waste streams arise from water supply and treatment, energy production and waste management operations, including some that have been recognised as presenting challenges by industry stakeholders and/or other parties.

The water sector produces multiple streams linked to drinking water treatment, sewage treatment, and the maintenance of water supply and sewage pipe networks. Major streams that TasWater has flagged as a concern include:

- Alum sludge and intermediate bulk containers (IBCs) with residual chemicals, both generated during drinking water treatment.
- Construction and demolition (C&D) waste including concrete waste dispersed across water utility sites, where distance is a factor in economically viable recovery.
- Obsolete and broken pipes made of concrete, plastic, and galvanised iron, that have been reserved onsite or left in situ following repair and replacement operations.
- Sewage treatment biosolids which are mainly recovered using low grade methods such as land spreading (with volumes containing high pollutant levels disposed of in landfill).

A substantial volume of general waste is associated with electricity generation, that may require further investigation for recovery opportunities. HydroTasmania raised the concern that more remote areas may have gaps in power system component recycling services.

While the energy utility isolates several waste streams for recovery, it is not fully confident that its waste contractor is always able to send those recoverable streams to a suitable recycling facility, particularly for wastes originating some distance from suitable recovery infrastructure. At present, HydroTasmania has expressed a need for greater certainty in the recycling of its batteries, steel, oil and power system components that arise at more remote sites. Over the coming period, it hopes to strengthen downstream tracking and reporting arrangements.

HydroTasmania also generates excavation spoil (i.e. hydro-excavation sludge) in large quantities associated with asset rebuild projects, although the majority of spoil that is free from chemicals of concern is typically reserved onsite and then used in land forming and contouring towards project completion. Spoil generated during hydro-excavation that occurs on or near contaminated land undergoes sampling and testing before disposal in accordance with its observed contamination levels, in line with corresponding compliance obligations.

The waste management sector generally focuses on the safe disposal of industrial wastes and the commercially efficient and environmentally sound recovery of useful materials available from commercial and industrial waste streams. However, there are some challenges linked with some resource recovery residues.

In particular, a large stockpile of shredder floc has been accumulating in northern Tasmania, due to the activity of a scrap metal recycler that has not been able to arrange the disposal of this controlled waste in a suitable landfill. The recycler has been required to cease operation of its shredder and to resolve its shredder floc stockpile issues, due to the risk posed by lead dust to the surrounding community and environment, and to the site's workforce.

Separately, there is one example of a material recovery facility (MRF) that produces a glass waste stream with substantial levels of impurities, such that the stream cannot be used for higher value commercial purposes. At present, this stream has been consigned to a landfill facility, despite the significant glass fraction that could be put to a range of local uses.

Figure 5: Discarded residual material from MRF processing activity occurring in northern Tasmania. While much of this stream is composed of glass, high levels of other recyclable materials and contaminants that were not removed during sorting preclude the use of this stream as a commercial input in various industries.

Overview of water utility waste streams and fates

Figure 6 overleaf provides an overview of the main waste streams associated with water utilities operations. This sector within ANZSIC Division D is shown in particular, due to the breadth of categories compared to other utilities described in the preceding pages. Some of the more niche waste streams (e.g. water meters, filtration membranes, pumps and UV disinfection units) have been omitted for clarity. As shown, there is a wide array of waste streams across drinking water treatment, sewage treatment, and supply and sewage pipe networks.

The diagram reveals a number of streams that are exclusively managed through disposal at landfill. There are also a number of streams associated with recycling plus one or more other activities (retention onsite, disposal). In some of these cases, the use of multiple management options indicates the gap in recycling services available to northern water utility properties versus southern properties. In other cases, such as in the case for biosolids, the distinguishing factor between recycling and disposal centres on pollutant loading levels. Such pollutants may include, in the case of biosolids, heavy metals, microplastics, PFAS, and pharmaceuticals and personal care product waste streams entrapped in the biosolid matrix.

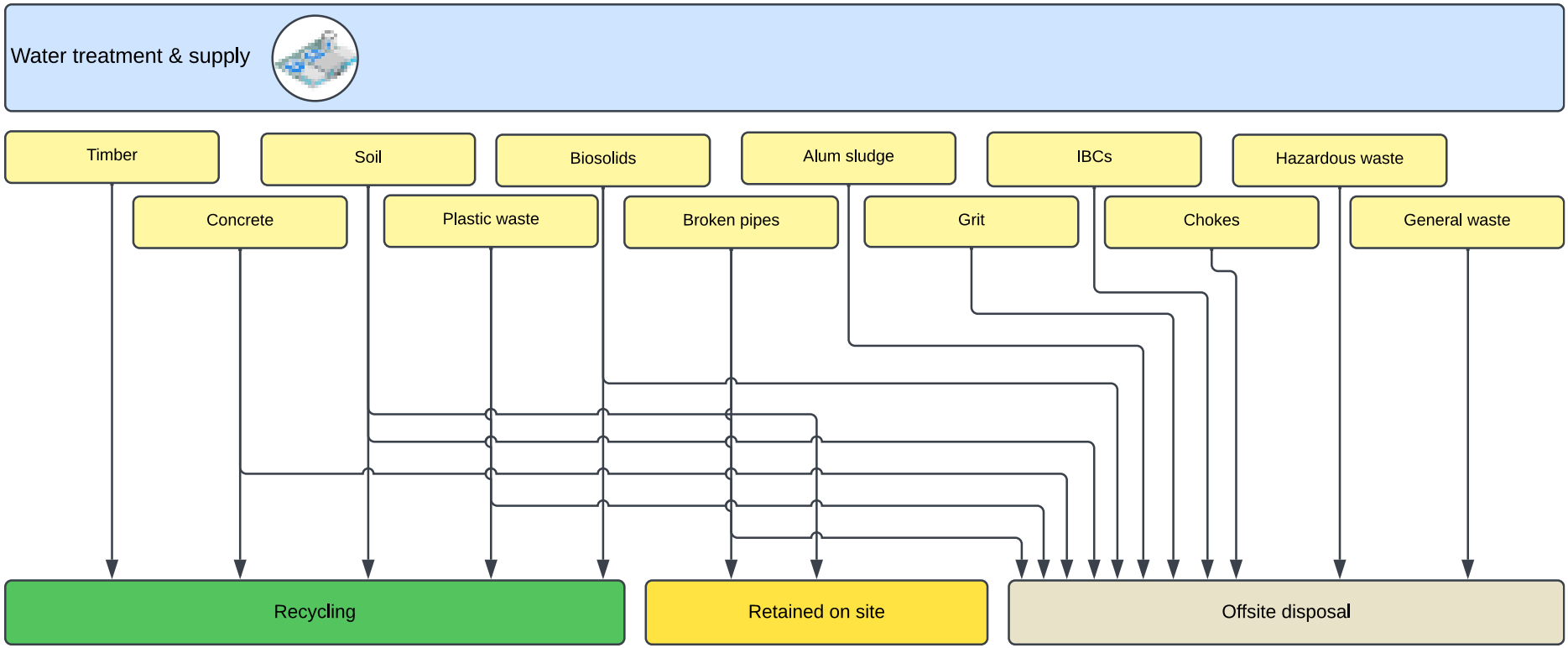

Figure 6: Overview of water utility waste streams and fates.

4 Consideration of streams against prioritisation criteria

At the commencement of this project, the WRR Board advised that it was seeking guidance on which industrial waste streams would be suitable to prioritise for improved management. This improved management could ideally involve higher value resource recovery or energy recovery. In the absence of alternatives aligned with the circular economy, improvement could conceivably stretch to involve disposing prolonged stockpiles in a manner that avoids ongoing and mounting risks to the environment, and that complies with environmental regulations and permit conditions.

A number of criteria for this prioritisation assessment were specified in the project brief released on behalf of the WRR Board, including the following:

- The extent and maturity of management options (based on an initial exploration)
- Hazard characteristics
- Market value or cost
- Social and environmental impacts.

These criteria were used to prioritise a set of waste streams from each of the sectors in scope for the project, alongside views on the importance of different waste streams raised by stakeholders. These perspectives from the industries that generate the waste are important, given the need for their buy in towards a solution, and the reliance on participating businesses to voluntarily provide those streams to a given solution.

4.1 Findings from use of prioritisation criteria

Table 4 below summarises the industrial waste streams that have arisen out of the prioritisation analysis, and stakeholder perspectives on challenging waste streams for which sustainable and/or more lasting solutions were seen as important.

These sixteen streams became the subject of Part 2 of the project, in which different technical and commercial solutions were explored and put forward, including a consideration of drivers and barriers affecting the establishment of those solutions in the Tasmanian market.

The exploration investigated technical, commercial, regulatory and supply chain considerations, with discussions organised around the maturity and level of precedence observed for different solutions. The investigation looked into the need for any preparatory activities to ensure priority waste streams were delivered in a format amenable for recovery, recycling or reuse. Based on a consideration of barriers to investment, roles and actions for the WRR Board's consideration were put forward. Findings from these explorations are set out in Chapters 5 and 6.

Table 4: Waste streams identified during engagement with industry representatives, which may hold significant opportunity to achieve improved environment protection and/or circular economy outcomes.

Stream	Source location(s)	Current management
ANZSIC Division A – Agriculture (Aquaculture only)		
Plastic ropes & flotation equipment (and other fish farm plastics not recycled or reused)	Salmon farms across Tasmania	Disposal in commercial waste landfills Limited recycling of some equipment categories
Soft and rigid plastic industrial & distribution packaging, particularly packaging contaminated with fish waste	Fish processing facilities	Disposal in commercial waste landfills Some limited recycling or reuse of less contaminated items
ANZSIC Division B – Mining		
Recyclable plant & equipment contaminated with removable hazardous materials	Mine sites that extract heavy metals and/or involve hazardous substances during initial processing	Onsite stockpiling or burial Some limited recycling
Equipment made of higher grade recoverable resources (poly pipe, cabling etc.)	Mine sites mainly across west and northwest Tasmania	Onsite burial or stockpiling Some limited recycling
Equipment made of rubber and metal – tyres, tracks, conveyors, mill lining, rubber hosing	Mine sites mainly across west and northwest Tasmania	Onsite stockpiling Some limited recycling
ANZSIC Division C – Manufacturing		
Byproduct from metal smelting, refining & alloying	Mainly isolated to Bell Bay Advanced Manufacturing Zone	Accumulated stockpiles within the premises of origin
Damaged / worn heavy duty machinery & equipment used in metal smelting, refining & alloying	Mainly isolated to Bell Bay Advanced Manufacturing Zone	Set aside in dedicated areas within the premises of origin Some limited recycling
Boiler ash generated from the timber products industry	At selected timber product manufacturing locations across Tasmania	Disposal to commercial waste landfills plus some low grade recycling (fertiliser input)
ANZSIC Division D – Water, Energy production & supply, Gas supply, Waste services		
Alum sludge	Drinking water treatment facilities	Disposal in commercial waste landfills
Plastic IBCs containing coagulated residues	Drinking water treatment facilities	Disposal in commercial waste landfills (with UBC reuse now emerging)
Biosolids (mainly organic but may have inorganic loading)	Sewage treatment facilities	Land spreading and some composting
Construction & demolition spoil dumps and concrete waste	Water utility sites dispersed across Tasmania	Onsite stockpiling Some disposal on a periodic basis
Obsolete and broken pipes made of concrete, plastic or galvanised iron	Drinking water & sewage pipe networks	Dispersed onsite stockpiling or buried in situ
Complex power & energy system components (stators, rotors, transformers, mechanical governor systems)	Remote power facilities that lack access to nearby recycling services	Disposal in commercial waste landfills with appropriate permits, some recycling where practical
Shredder floc	Scrap metal recycling premises	Onsite stockpiling
MRF residues containing glass impacted by impurities	MRFs that do not refine glass using beneficiation technologies	Disposal in commercial waste landfills

4.2 General waste as a common category across industries

When engaging with industry representatives and reviewing EPA required AER documents, it became evident that a significant fraction of business waste streams is categorised as 'general waste.' This follows the use of this term in commercial waste service contracts, and language used by waste contractors when reporting back to an industrial customer on volumes.

In essence, one or more bins placed on an industrial premise may be designated as general waste bins, which the contractor then transports for disposal to a nearby landfill which is permitted to accept general industrial waste. Depending on the customer, there may be some inspection to confirm that the waste will comply with waste contract conditions and landfill acceptance conditions, or to investigate missed opportunities for waste diversion.

However, there appears to be limited attention towards or understanding of the general waste stream in most businesses, beyond this somewhat cursory level of investigation.

A range of potentially recoverable materials may reside in this general waste stream, depending on the specifics of each individual business. These include e-waste, fabric and textiles including uniforms and work wear, single use and reusable personal protective equipment, rigid plastic consumables and end of life equipment, and potentially other items. On this basis, there may be a merit in encouraging audits of the general waste stream to take place on a periodic basis, to better understand the extent of materials that may be recovered and to inform the viability of targeted recovery solutions.

PART 2 – Exploring solutions and actions for priority industrial waste streams

5 Taking action on priority industrial wastes

This chapter is dedicated to an exploration of potential solutions for each of the priority waste streams determined during Part 1, where those potential solutions generally involve an improved alignment with the waste hierarchy and circular economy principles compared with business as usual practices.

Each exploration includes a discussion of factors that may assist or deter the adoption of that solution in Tasmania, to better enable the WRR Board and other parties to work through challenges and supporting activities as needed to drive change. Sections covering each stream conclude with tables setting out potential actions for the WRR Board's consideration across a range of themes, i.e.:

- Engagement and brokering focused on waste generators and potential solution providers
- Spatial mapping of waste materials (stocks and flows) and planning for suitably located, scaled, and equipped infrastructure to deliver efficient circular economy functions
- Coordinated regulatory reforms and enforcement to encourage circular economy outcomes
- Support for local commercialisation and investment across recovery supply chains.

This general list of actions for the WRR Board and its strategy implementation partners may be adapted for other waste streams and industries that are not in scope for the present work, providing a means for the WRR Board and wider Tasmanian Government to equip itself to promptly respond to emerging interests. It also helps ground some more generalised activities (e.g. data collection, engagement and consultation) within the WRR Board's legislated functions towards achieving specific objectives that may be aligned to the *Tasmanian Waste and Resource Recovery Strategy*.

The actions linked to each individual stream may be considered in conjunction with recommendations forwarded in Chapter 6. The WRR Board may also refer to Section 1.5, which guides the interpretation of actions and findings more generally, in incorporating these actions into planning and implementing successive iterations of the *Tasmanian Waste and Resource Recovery Strategy*.

While lead organisations for action delivery are put forward in this chapter, the team is not involved in WRR Board processes to delegate any actions or to form delivery partnerships with any third party organisations. WRR Board negotiations with third parties to deliver any actions (and accept related accountabilities) on the Board's behalf may be explicitly linked to one or more strategic outcomes or objectives.

5.1 Streams with established versus emerging recovery methods

The list of priority streams laid out in the previous chapter may loosely be grouped according to whether there are recycling or recovery technologies that are well established for the main materials found in that stream, which could be adopted in Tasmania under the right conditions. From the list, there is evidence that some streams are almost fully composed of material which is recyclable using mature technologies, although there are some challenges relating to logistics, market access, disassembly and size reduction, and/or addressing industry-specific contaminants. Other streams involve materials whose recovery relies on technologies that are far less developed at the current point in time, or have modest to no precedent in Australia to date.

The table below suggests a potential separation between these two broad categories. Some sub-headings are also provided to indicate a practical set of grouping within each category, where streams within each grouping have a degree of commonality. For example, recyclable plastics occur across a number of industrial waste streams; and some industrial streams may be likened towards construction and demolition wastes specific to one or more industries in ANZSIC Industry Divisions A through D.

Streams involving commercially established recovery technologies	**Streams involving emerging recovery technologies**
Soiled industrial plastics • Plastic ropes & flotation equipment • Plastic industrial & distribution packaging, including with fish waste contamination • Plastic IBCs containing coagulated residues ***Heavy duty mining & power equipment*** • Mining plant & equipment (contaminated with hazardous materials) • Mining equipment made of higher grade recoverable resources (uncontaminated) • Rubber containing streams (tyres, tracks, conveyor belts, mill lining, rubber hosing) • Complex power & energy system components (stators, rotors, transformers, mechanical governor systems) ***Inert industrial aggregates*** • Construction & demolition spoil dumps and concrete waste • Obsolete and broken pipes made of concrete, plastic or galvanised iron • MRF residues containing glass impacted by impurities	***High moisture content industrial wastes*** • Alum sludge from treating drinking water • Biosolids from treating sewage water ***Metal byproducts & processing residues*** • Byproduct from metal smelting, refining & alloying • Damaged / worn heavy duty machinery & equipment used in metal smelting, refining & alloying ***Other miscellaneous streams*** • Boiler ash generated from the timber products industry • Shredder floc

The sub-headings used in this table are used below to explore and weigh up potential challenges and solutions for their constituent waste streams. This grouped approach allows for a discussion of common issues with minimal repetition while also identifying where there may be industrial synergies and economies of scale and scope for recovery technologies.

5.2 Streams requiring investment in established technologies

Group 1: Soiled industrial plastics

- *Plastic IBCs containing coagulated residues*
- *Plastic ropes & flotation equipment (and other fish farm plastics not recycled or reused)*
- *Soft and rigid plastic packaging, including packaging contaminated with fish waste*

This group of industrial wastes is concerned with plastics used in aquaculture, water supply and potentially other industries, where the material itself is homogenous (a 'mono-plastic') but its surface may be contaminated with residues, fouling and other substances. These contaminants lead to an unwillingness from conventional plastic recycling businesses to accept the waste, even if the underlying material is highly valuable. Further details on each stream in this group are provided below. While the focus of this section is on these streams, there are likely to be other plastic wastes – such as plastic piping used in the mining and water supply sectors, and plastic silage, ropes and netting used in agriculture – that may be amenable to recovery through the same treatment processes.

Plastic IBCs containing coagulated residues

The water sector uses plastic intermediate bulk containers (IBCs) to store and dispense chemical additives that are required to improve water quality. These rigid plastic cubes are made to an international standard to contain up to 1 cubic metre of liquid and may typically be housed in a reusable steel cage or frame for safe and convenient storage and transport. IBCs are typically made from rigid HDPE and can be washed and reused, or alternatively recycled. They are widely used to store a range of liquids, including dangerous goods, across different industries. TasWater has reported that recyclers had been unwilling to accept used IBCs that contain a level of coagulated residues, which has led to their being disposed in landfill over successive years.

Soft and rigid plastic packaging, including packaging contaminated with fish waste

Aquaculture industry documents (AERs and sustainability reports) identify soft plastic waste streams generated during processing, packaging and distribution as a challenge. In particular, soft plastics that have been in direct contact with fish are difficult to recycle due to potential contamination. More generally, all soft plastics are a recycling challenge in the aquaculture sector and beyond, particularly due to their low weight and their tendency to become entangled with recycling equipment that has not been designed to handle soft plastics. This entangling can contribute to wear and operational disruption, while also contaminating other streams that a recycling facility may be attempting to recycle.

A facility that is able to clean and recycle soft plastics soiled with fish waste may be able to manage other soft plastics from aquaculture and other sectors. While industrial soft packaging is often constructed from LDPE, soft HDPE and soft PP are also used for various applications.

Plastic ropes & flotation equipment (and other fish farm plastics not recycled or reused)

Sustainability reports from the aquaculture industry suggest that plastics used in fish farms have been a priority for recycling, although engagement with the waste sector indicates that some categories of plastic equipment are still being sent to landfill. While ropes and flotation equipment were specifically mentioned, other items may also be going to landfill (although were not mentioned during engagement). Also, aquaculture sustainability reports suggest that some fish pen nets have been offered to other sectors (e.g. farms) for reuse applications, which may ultimately defer but not prevent disposal in landfill, unless some other solution emerges.

Some of the plastic products used in fish pens (such as ropes and nets) are known to use tough and resilient plastic fibres which are resistant to processing via standard plastic recycling equipment. In the case of items that have been floating or submerged in a marine environment for extended periods, there may be significant contaminants or fouling – sand, grit, excreta, marine organisms, etc. – both attached to the outer layer and between layers or filaments that pose challenges for clean up and recycling, while also causing vermin and odour issues once the items are taken ashore.

These challenges will need to be dealt with in establishing a sustainable recycling solution for aquaculture plastics including ropes, nets and other fouled items. Notably, there may be other industries such as the agriculture industry that have similar issues. A solution for aquaculture plastics recycling may therefore lend itself to the recovery of similar items in that sector (e.g. ropes, twine, plastic silage, shade cloth, woven synthetic fabrics, etc.)

Potential solutions for soiled industrial plastics

Plastic IBCs containing coagulated residues

A number of solutions appear to have been developed internationally, specifically for thoroughly cleaning IBCs and removing difficult residues. US-based PRI Systems[10] and UK-based Arcus Cleaning Systems[11] have both developed solutions that use high-pressure rotating water jet nozzles, designed to clean the interiors of used IBCs. Each company's website claims to be able to deliver cleaned IBCs in ten minutes or less, which may then be reused or recycled according to the market opportunities at hand. The websites also include case studies, testimonials and stated commitments towards working in partnership to develop optimal solutions with clients.

In the case of PRI Systems, they have additionally developed plastics recycling assembly lines, which may potentially be used for recycling the IBC. However, once clean, it is likely that there are a wider range of Australia-based, commercially available options to shred and store commercial grade recycled HDPE flakes.

At the time of writing, there are some examples of IBC inspection, cleaning and testing activities being integrated into the supply of industrial chemicals. The Tasmanian water sector advises that one chemical supplier is now able to work empty IBC pick up and refurbishing into their supply contract, and there is optimism that other suppliers will follow this model. In Western Australia, at least one industrial chemical supplier has used its ability to pick up, clean and repurpose used IBCs as a competitive selling point.[12] Other integrated solutions may be occurring elsewhere in the Australian industrial chemicals sector.

While clean and intact IBCs may be of sufficient value that they can be refilled either in Tasmania or shipped to mainland Australia for refilling, it is reasonable to expect that IBCs marked for recycling would need to at least be partially processed (i.e. shredded or sliced into flat sheeting) in Tasmania before being shipped out of the state, to keep transport costs to a minimum.

With perhaps several hundred IBCs used and disposed of by TasWater each year, the water utility may not have sufficient demand for dedicated IBC cleaning equipment on its own, so it may be more efficient for this activity to be taken on by a third party that could potentially serve other IBC users that are currently resorting to disposal. This third party may potentially be a

[10] https://prisystems.com/products/industrial-process-systems/container-washing/rotajet-d-series/
[11] https://www.arcuscleaningsystems.com/products/vasa-tank-and-ibc-cleaning-system
[12] https://agentindustrial.com.au/ibc-recycling/

waste management business, an industrial chemicals or containers supply company, or some other business involved in industrial logistics and/or sanitation whose existing business processes are compatible with taking on IBC cleaning, inspection and designation for reuse or recycling.

Soft and rigid plastic packaging, including packaging contaminated with fish waste

In recent years, a number of solutions dedicated to soft plastics recycling have begun to emerge in Australia and beyond, including more specialised mechanical recycling and advanced chemical recycling techniques. Remondis Australia has recently commissioned equipment in Perth, to process soft plastics used in supply and distribution (i.e. not post-consumer mixed plastics, but pallet wrap, film, and liner material used by industry) into clean LDPE pellets.[13] In incorporating a wash process, the technology may be able to deal with soiling by various residues.

The central piece of equipment appears to be a washing and grinding unit called the Erema Intarema RegrindPro, sourced from Cemac Technologies in Austria. Evidently, this equipment was partially funded from Western Australian Government and Commonwealth Government funding under the Recycling Modernisation Fund.[14]

A separate mechanical recycling facility for soft plastics is presently under development in South Australia, which is designed to accept post-consumer and commercial soft plastics. This facility is based on a technology that uses high water pressure and friction to scrub plastic fragments of contaminants and other surface residues prior to recovering flaked plastic products. This HydroCleaner technology[15] is developed in Germany by HydroDyn, with PreOne International carrying the exclusive Australian licence.[16]

The project received $40 million in funding, including $20 million via the Recycling Modernisation Fund. The facility will be operated by Recycling Plastics Australia, with a planned capacity to recover up to 14,000 tonnes of soft plastic each year.

On face value, the equipment supplied by HydroDyn / PreOne International and by Cemac Technologies would appear to be suitable for processing soiled LDPE film from the aquaculture sector, and soft plastics arising from other sectors including agriculture, logistics and wholesale distribution. Volume from these other industries may be essential to ensuring sufficient material throughput and related cashflow to drive confident investment in a new facility.

Plastic ropes & flotation equipment (and other fish farm plastics not recycled or reused)

As stated above, ropes, nets and other plastic equipment used in fish farms are designed to be hardy enough to withstand extended periods of demanding use in and around marine environments, and are also prone to multiple persistent contaminants that arise from that environment. Depending on the item in question, the contaminant may attach to the outer surface of the plastic equipment, but may also be trapped within layers and filaments. Some specialist ropes also include contaminants by design such as anti-fouling coating or metals used for strengthening, fouling resistance, and altering the rope's buoyancy characteristics.

A subset of aquaculture plastics, including ropes and netting and possibly flotation devices, appear to be incompatible with plastics recycling technologies that have been typically deployed to recover other types of plastics. Marine plastics in general, including aquaculture and fishing

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[13] https://www.remondis-australia.com.au/rethink-plastics-recycling/
[14] http://www.wa.gov.au/service/environment/environment-information-services/recycling-modernisation-fund
[15] https://www.hydrodyn.de/en/products/
[16] https://www.packagingnews.com.au/latest/new-40m-soft-plastics-recycling-plant-underway

plastic equipment, carry the additional problem that some proportion of equipment is lost to the industry and may become an ecological hazard (in the form of 'ghost gear' and water-borne microplastics).

This has led to a number of fishing equipment recovery efforts being developed, including the Australian Marine Debris Initiative[17] and Waterhaul UK. The latter collects ghost nets from UK coastlines to recycle them into sunglasses, litter pickers and other items for sale to the public.[18] A similar approach to Waterhaul is taken by Odyssey Innovation, a company based in southwest England that collects ghost nets and has the plastic recycled into sea kayaks, body boards and other products by its Denmark-based recycling partner, Plastix Global.[19]

In terms of technological solutions, the recycling of marine rope, nets and other plastic aquaculture equipment is still an emerging field. A company based in the Netherlands, Healix, appears to have developed a technology and workflow that is specialised for the recycling of fishing nets and ropes, and a range of agricultural plastics (including ropes, bulk bags, bird netting and other items), which may be amenable to recycling aquaculture nets and rope.[20] Healix' integrated solution is claimed to work at a 6,000 tonnes per year capacity and upwards, incorporating several steps for recycling HDPE and PP:

- Pre-sorting and cleaning of received plastic waste streams
- Polymer fibre size reduction (shredding)
- Washing and drying of separated filaments
- Melting, filtration and extrusion into commodity grade plastic pellets.

A breakdown of the Healix process flow is provided online.[21] Evidently, the product can be sold into global commodity markets, including into supply chains in the production of new ropes, nets, bulk bags and other industrial products.

The Healix technology appears to provide an integrated model for recovering difficult plastic streams that are mechanically tough and resistant to standard processing methods, and that are extensively contaminated. The integrated approach generates a finished commodity directly from the point of waste generation, which may help to avoid a range of supply chain risks.

Material flows and supply chains

In the diagram overleaf (Figure 7), indicative workflows for the recovery of the three soiled industrial plastics (covered above) are depicted. While the focus is on priority plastic wastes from the industries covered in the scope of this work, other potential sources of feedstock are also shown. These other sources may be important to provide a recycler with diversification options, thereby de-risking their business model, while also helping to ensure sufficient use of capital and equipment over a given period.

[17] https://tangaroablue.org/about-amdi/
[18] https://waterhauls.com.au/
[19] https://odysseyinnovation.com/pages/about-us-odyssey-innovation-our-odyssey
[20] https://healix.eco/
[21] https://healix.eco/oceans/

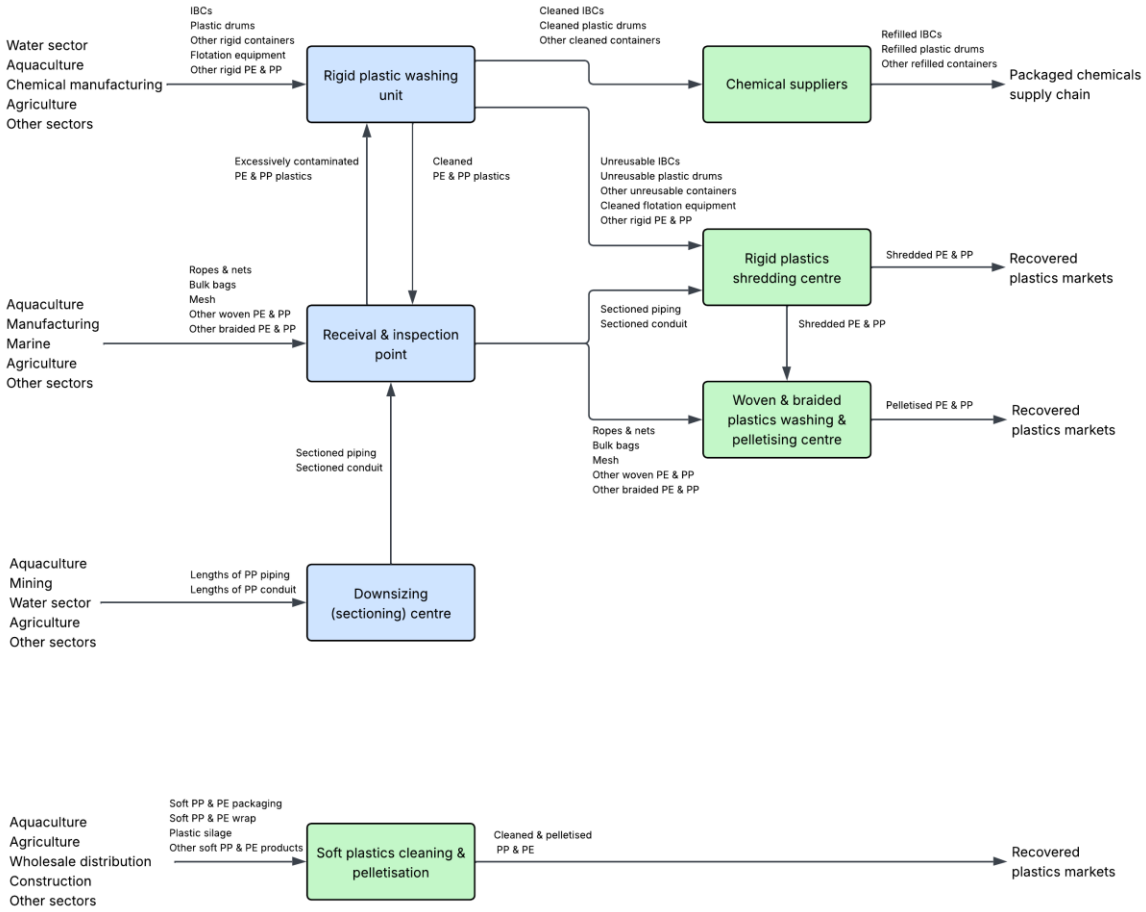

Figure 7: Potential configuration of industrial plastics recovery technologies, including interactions between different activities needed to recover industrial plastics. Focus of this diagram is on PP and PE streams, including some streams that are not in scope (to indicate additional feedstocks). Investment may occur in selected technology areas to allow recovery of a subset of industrial plastics, as opportunities arise.

Action recommendations

Plastic IBCs containing coagulated residues

Priority stream	**ANZSIC Industry**	**Other industries**	**Solution(s)**	
Plastic IBCs containing coagulated residues	D – Water utilities	Manufacturing Agriculture	High pressure washing followed by reuse or HDPE recycling	
Action			Action area	Lead organisation(s)
Engage with TasWater and their chemical suppliers that ship product in IBCs on usefulness of high pressure washing equipment, and potential responsibility and location for its operation. Engage similarly with other industry sectors that are supplied chemicals with IBCs and other large rigid plastic containers.			Engagement & brokering	WRR Board

Allocate funding to IBC high pressure washing equipment. Pending its commissioning and details of residual containers that cannot be reused, allocate funding to rigid plastic shredding equipment able to process large industrial HDPE containers including IBCs.	Support for local commercialisation & investment	WRR Board

Soft and rigid plastic packaging, including packaging contaminated with fish waste

Priority stream	**ANZSIC Industry**	**Other industries**	**Solution(s)**	
Soft and rigid plastic packaging, including packaging contaminated with fish waste	A – Aquaculture	Manufacturing Wholesale & distribution Construction Agriculture	Mechanical recycling able to process HDPE, LDPE and/or PP post-industrial (i.e. not post-consumer) soft and hard plastics.	
Action			Action area	Lead organisation(s)
Engage with APCO and Tasmania-based members to investigate total quantities of soft industrial and wholesale plastics from the aquaculture sector, commercial wholesale and distribution businesses, and other Tasmanian sectors, to determine whether quantities are sufficient to drive investment in soft plastics mechanical recycling technologies.			Engagement & brokering	WRR Board
Pending confirmed volumes available for recovery, allocate funding to soft plastics and rigid industrial (i.e. not post-consumer) plastics mechanical recycling capacity, able to process LDPE, HDPE and PP materials.			Support for local commercialisation & investment	WRR Board

Plastic ropes & flotation equipment (and other fish farm plastics not recycled or reused)

Priority stream	**ANZSIC Industry**	**Other industries**	**Solution(s)**	
Plastic ropes & flotation equipment (and other fish farm plastics not recycled or reused)	A – Aquaculture	Marine Manufacturing Agriculture	Specialised recycling equipment that is able to clean and pelletise high contamination woven and braided plastics. May require pre-cleaning to remove excessive surface contaminants and fouling.	
Action			Action area	Lead organisation(s)
Engage with aquaculture sector, fishing, marine and other sectors that use rope, nets, woven fabric and other products made from PP and HDPE, to further understand their volumes and potential interest in recycling plastic waste. Explore interest in trials to substitute other plastics with HDPE and PP alternatives as a means to simplify the profile of wastes used in these sectors, and make it easier to sort end of life plastic equipment.			Engagement & brokering	WRR Board
Meet with international leaders in marine plastics recovery (e.g. based in UK and the Netherlands), including those using mature collection and aggregation models and recycling technologies, to			Engagement & brokering	WRR Board

learn from their experience and understand how their methods and technologies may be transferred to Tasmania.		
Based on findings from industry and solution engagement, determine a preferred configuration of commercial services and technologies to recover ropes, nets, flotation equipment and other recoverable plastics, and allocate funding to address gaps in private investment.	Support for local commercialisation & investment	WRR Board

Group 2: Heavy duty mining & power equipment

- *Mining sector rubber containing equipment*
- *Recyclable mining plant & equipment (contaminated with hazardous materials)*
- *Recyclable mining plant & equipment (uncontaminated)*
- *Complex power & energy system components*

This grouping of industrial waste streams deals with heavy duty and technical equipment associated with mining and power sectors (although other sectors' waste streams may exhibit similar characteristics). Engagement with mining and energy sector businesses suggests that a proportion of each of these streams is being recycled at present, although the level of service for recycling in some more remote parts of the state was at times described as inadequate. Some capacity may exist for recovering these items (either through facilities based in Tasmania or further afield), although the services do not sufficiently reach some points of generation.

Logistics and handling challenges, associated with physical dimensions and distances involved with recycling the items in question, are at the heart of the incomplete recovery of these industrial waste streams. Industry-specific contamination may add another layer of complication to the movement and handling of these streams. For example, depending on the site and core business, some of the wastes in this category may be coated or impregnated with heavy metals, industrial acids, fluorides, cyanides and synthetic oils including polychlorinated biphenyls (PCBs).

Barriers to recycling are exacerbated by a tendency for the mining sector to accumulate end of life consumables and equipment onsite as enabled by their environmental permit conditions, which can allow mining businesses to defer spending on recovery solutions over longer periods.

Mining sector rubber containing equipment

These wastes involve heavy duty rubber products mainly used in mining but also industrial materials handling processes. Engagement with the mining sector suggests that heavy vehicle tyres represent the largest amount by mass, with other wastes also being generated and, in some cases, stockpiled. The rubber waste streams in this category are mainly composed of vulcanised natural and synthetic rubber, high strength metals (steel or aluminium), and possibly a synthetic fabric layer made of nylon or some other polymer. The rubber matrix is itself composed of rubber, carbon black, and various strengthening and durability additives.

Engagement with the mining sector indicates that rubber containing streams are potentially the most urgent waste to deal with. In part, this is due to the growing disposal / recovery liability associated with Off The Road (OTR) tyres, tracks, conveyor belts, mill liners and hose stockpiles that may accumulate over many years. But equally, there is concern that these stockpiles carry a major fire risk for the companies that are liable for these waste streams, and this drives a desire to confront this risk through action. However, waste tyre logistics can be rendered difficult due to the large size of OTR tyres and low to moderate value of recovered tyre derived products.

OTR tyres used in the mining sector may be grouped into two categories associated with different types of mining. The largest tyres arise from the use of open cut haulage vehicles, and represent the greater difficulty in recycling. These tyres may weigh as much as five tonnes, and may have a diameter in the order of four plus metres in length. In contrast, underground mining tends to involve vehicles that use smaller tyres, while also using conveyors to substitute for vehicles in some mines. Conveyor belts are more generally used to move excavated ores in a processing facility, at a storage site, when loading onto ships, or in other materials handling applications in and beyond the mining sector.

Recyclable mining plant & equipment (contaminated and uncontaminated)

Aside from rubber containing items, substantial volumes of other plant, equipment and engineering waste streams are generated on mining sites. In some cases, those waste streams mainly occur during site decommissioning, and are a lesser concern as they should be covered by a closure and rehabilitation plan authorised by the Tasmanian Government.

However, a range of heavy equipment wastes may be produced on an ongoing basis over the operational lifespan of a mine including vehicles; batteries; pumps, generators, transformers and other machinery; industrial cable, conduit and piping; and so on. Some level of contamination may be present, depending on the metals being mined and the steps taken to extract and refine one or more commodities. However, putting aside this question of contamination, none of the above mentioned examples of heavy equipment are inherently difficult or challenging to recover, once logistical and transport issues are dealt with.

Industry engagement suggests that some of these streams are being recovered from some mines, but a proportion may be accumulating over an indefinite period or may be disposed of in unused mining voids or pits as a matter of convenience. To a degree, this may be the pragmatic option where there is a lack of physical presence in recycling capacity in locations close to the mine, i.e. on the grounds that it may be uneconomical to engage in recycling where a facility is located long distances from the mining site. Similarly, a lack of nearby cleaning and decontamination facilities may also be a basis to substantiate ongoing disposal. However, the option to accumulate on site may in itself erode the case for investing in recovery activities that target equipment and consumables from the mining sector.

Complex power & energy system components

Engagement with the energy sector in Tasmania suggests that there may be some similar challenges in this sector as faced by mining companies that are located a distance from recycling infrastructure. It has been reported that high voltage power components (stators, rotors, transformers, mechanical governor systems) can and should be recycled, although there is less certainty that takes place for equipment that reaches its end of life in remote parts of the state.

Some ability to verify the waste's movement between the point it becomes a waste through to its receival at a recycling facility may provide greater assurance that recycling is taking place. Similarly, there may be benefit in the development of dedicated aggregation points in more remote locations, where decontamination and dismantling can take place efficiently, which serve as industrial waste transfer stations ahead of final processing (which could take place at the same location or may involve consolidated transport).

Potential solutions for heavy duty mining & power equipment

Mining sector rubber containing equipment

Any near term recovery for rubber products from the mining sector is likely to involve mechanical recovery of tyre derived fuel (tyre shred between 50mm and 150mm in length); or grinding into granule or crumb. Other technologies such as pyrolysis or devulcanisation are some distance from commercial maturity in the Australian marketplace.

A typical workflow for larger OTR tyres (open cut vehicle tyres) and other larger products may involve the following steps:

1. Size reduction using hydraulic shears or specialised heavy duty slicing equipment to section the tyre into smaller pieces that are easier and more efficient to transport. Option to then pass these pieces through a coarse shredder, to further improve handling and transport efficiencies.
2. Transport via containers to a tyre shredding or tyre crumbing facility, for processing and packaging for final use.
3. Final usage, which may involve use of tyre shred in a kiln, boiler or furnace as an alternative fuel; or alternatively, use of crumb rubber as an additive to improve road performance (with the steel component separately refined and recovered).

Other workflows – such as the production of granules and powders – may alternatively take place, depending on demand for these materials. In the case of smaller (underground) mining tyres, the first step (above) may be bypassed, depending on dimensions. The need to size reduce conveyor belts, tracks or other products may be weighed up on a case by case basis.

Engagement with the mining sector suggests that there is the internal capacity for some companies to perform an initial size reduction step. However, during their exploration of steps required after that point, it was viewed that the available options were economically challenging as explained below.

The current on island solution – to have the sectioned tyres shredded in Brighton Council – may be unviable as the intended focus of this facility is to process smaller passenger car and truck tyres.[22] OTR tyres that have been cut into sections may be small enough to feed into the facility, but their thick cross sections and high tensile strength steel components may not be compatible with the facility as it is presently configured. Further, the facility has been designed to deliver shred to specification for the Railton cement kiln. This kiln's approved acceptance of tyre derived fuel may be capped such that it cannot accept additional tyre derived fuel prepared from mining tyres and other rubber products. The kiln may need to clear an added phase of testing and upgrade before accepting tyres and other rubber products from the mining sector.

The other immediate option may be to have the sectioned tyres and other products shipped to mainland Australia for further processing (e.g. into crumb rubber or granule). However, during engagement, mining companies with open cut OTR tyres deemed that the cost to ship and process the sectioned tyres was not commercially affordable at the rates that were offered.

The team also notes that representatives of at least one mining company indicated that they have established a take back arrangement (advanced disposal fee) embedded within their current contract for supplying OTR mining tyres. Through this arrangement, end of life OTR tyres

[22] https://www.premier.tas.gov.au/latest-news/2024/may/better-on-island-tyre-processing-on-the-way-after-government-grant

are consolidated and shipped back to the mainland rather than stockpiled onsite. The potential for these types of arrangements to become more prevalent across the mining sector is worth exploring, along with potential impacts on the viability of on-island processing.

The above suggests merit in exploring the viability of setting up dedicated OTR tyre processing activities (shredding and or crumbing, for example) in Tasmania, either on a permanent or periodic basis. In exploring this viability, there is a need to explore the underlying economics and related barriers given a limited quantity of tyres and other rubber products generated from mining and other activities (i.e. constrained demand for tyre recycling services) and potentially limited demand in markets such as road building, cement manufacture and other applications. Equally, the permission to accumulate waste rubber products on mining sites over longer timeframes needs to be considered in its role as an impediment to solution investment.

Recyclable mining plant & equipment (contaminated and uncontaminated)

Earlier in this section it was noted that there are no outstanding technical issues that prevent heavy duty mining equipment being recycled and if necessary, decontaminated prior to being recycled. Instead, the issue arises from a combination of permissions to dispose of or indefinitely stockpile recyclable equipment waste onsite, and a perceived absence of locally available recycling solutions that enable efficient supply chains. These factors reinforce each other.

A potential pathway out of the present dynamic may involve the following steps designed to create efficiencies in the mining sector's access to recycling while signalling an opportunity to service providers that onsite disposal and long term stockpiling will no longer be permitted.

- A more accurate assessment of recyclable equipment being recycled, disposed of and/or accumulated at Tasmanian mining sites, focused on volume, composition and extent of type of contamination.
- Engagement on market capacity to invest in recycling solutions for those items where recycling is occurring to a limited degree (or not at all), to inform the scope of materials and activities that need to be dealt with through an aggregation point to support an efficient decontamination, clean up and recycling supply chain for mining equipment.
- Completion of a siting study for the general location of this aggregation point, including potential benefits in being able to service other sectors that use heavy equipment.
- Investment in a suitable staging ground located close to mining activities, that functions as a location to decontaminate, dismantle, size reduce, and safely manage recyclable streams from the mining sector. This site would work as a heavy industry waste transfer station to allow for handling and aggregation prior to further processing downstream.
- Revised environmental permit conditions to require mining companies to take prescribed categories of end of life equipment offsite for recovery (using heavy industry waste transfer station or going directly to a processing facility), with revised permissions to restrict holding or disposing the equipment onsite.

Notably, operators occupying this facility could provide a degree of supply chain transparency on behalf of mining companies and other industrial customers. This is achieved by taking responsibility for tracking systems to ensure that items removed from the facility are being legitimately recycled involving parties with a sound track record in environmental due diligence and worker safety.

Complex power & energy system components

In terms of a solution for the recycling heavy duty and high voltage power equipment, the proposed approach for mining plant and equipment may be effective. However, the sector may have more dispersed equipment waste, suggesting value in a network of smaller consolidation points that are distributed across state (which nonetheless may be managed via one or more larger industrial waste transfer stations). The above tracking and traceability function is expected to be useful to the energy sector, as a key concern raised during engagement was the lack of certainty that all recyclable streams were genuinely reaching recycling destination points.

Material flows and supply chains

In the diagram (Figure 8) below, indicative workflows for the recovery of different types of mining equipment and heavy duty power equipment (covered above) are depicted. The workflows show provisions to limit the extent of onsite (multi-year) stockpiling of recyclable materials, with the option to set up and use an offsite storage and consolidation facility.

The recovery of rubber equipment is only shown in general terms as a separate exploration into solutions for mining tyres and related equipment has been initiated (and is being progressed at the time of writing).

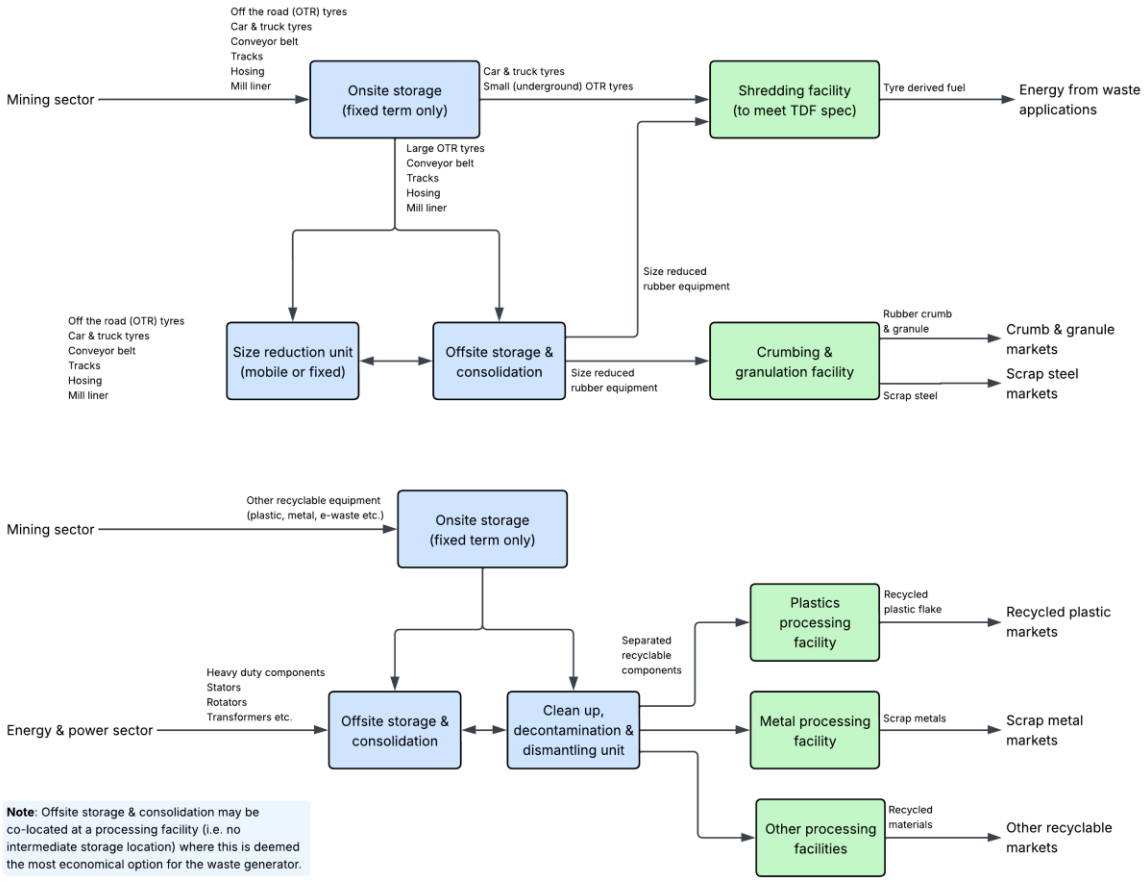

Figure 8: Potential configuration of mining and energy & power sector equipment recovery technologies, including interactions between different activities needed to recover rubber and metal commodities, and other recycled goods. The diagram may be read as an indicative example of how different activities work together, noting that a separate body of work is (at the time of writing) more closely examining technology options to recycle mining-related rubber and plastic equipment.

Action recommendations

Recyclable mining plant & equipment (contaminated and uncontaminated)

Mining sector rubber containing equipment

Complex power & energy system components

Priority stream	ANZSIC Industry	Other industries	Solution(s)	
Recyclable mining plant & equipment (contaminated and uncontaminated)	B – Mining	N/A	Mechanical recycling of recyclable equipment (e.g. into aggregates, recovered metals, plastic, timber etc.). May require decontamination, clean up, dismantling or size reduction as an initial step to improve logistical efficiencies.	
Mining sector rubber containing equipment	B – Mining	Agriculture Construction Heavy vehicle fleet	Mechanical processing into shred (for waste derived fuel) or into rubber crumb/granule and recovered steel. Will require size reduction beforehand (e.g. coarse shredding or sectioning, possibly removal of metal beading).	
Complex power & energy system components	D – Energy	Heavy industry Ports Rail network assets	Mechanical recycling of recyclable components, potentially including decontamination and disassembly prior to recovery through general purpose mechanical recycling facilities.	
Action			Action area	Lead organisation(s)
Conduct a structured engagement process with the mining sector to further characterise heavy plant & equipment and rubber equipment usage rates, recycling needs across the supply chain, and recovery levels. Put forward solutions for the mining sector's consideration, which may need to include steps to decontaminate, clean up, dismantle or size reduce plant and equipment – either at a localised heavy industry recycling precinct / transfer station or using mobile equipment. Separately engage with the energy generation sector (HydroTasmania) on the scope and placement of facilities to aid the efficient recovery of complex power and energy component streams generated in remote energy asset locations.			Engagement & brokering	WRR Board
Encourage development of heavy industry waste transfer station(s)/ circular economy precinct(s) located close to mining sector activity and major energy assets, that can support the efficient clean up and preparation of recyclable plant and equipment including rubber containing equipment for recycling, while delivering traceability and reporting functions to the mining company. This encouragement may take the form of: • Funding for a study into site functions, scopes of activity, and potential locations of one or more heavy industry transfer stations / mixed resource circular economy precincts • Potential co-funding (capital investment) in heavy industry circular economy precinct / transfer station			Spatial mapping & infrastructure planning Support for local commercialisation & investment	WRR Board DSG

site / mobile processing and treatment activities where they improve heavy industry waste recycling and traceability of downstream activities.		
Revise mine site permit conditions to reduce the extent of onsite disposal of recyclable plant and equipment; to place hard limits (volumes and timeframes) for the stocking of end of life recyclable plant and equipment on mining sites; and to upgrade traceability and reporting to EPA on volumes, stockpiles, locations and movements of end of life recyclable plant and equipment generated on mining sites. These revisions should account for the extent of local impacts and risks, and the availability of suitable recycling technologies available in Tasmania and elsewhere. Exemptions may be necessary for recyclable items that are irreversibly impacted by high toxicity chemicals of concern.	Coordinated reforms & enforcement to drive the circular economy	EPA

Group 3: Inert industrial aggregates

- *Construction & demolition spoil dumps and concrete waste from water utility assets*
- *Obsolete and broken pipes made of concrete, plastic or galvanised iron*
- *MRF residues containing glass impacted by impurities*

This grouping of waste streams involves materials that are relatively inert, and have been accumulating as waste piles, or are being generated due to past and current activity. Apart from some water pipes made from plastic or metal, the majority of these streams could be refined and managed as some form of recycled aggregate used in civil applications. Those pipes that are fabricated from plastic or metal may be amenable to recycling using well established technologies if issues centring on logistics, large dimensions, and removal from extraneous materials (e.g. dirt build up) were addressed.

The water sector construction & demolition waste and obsolete and broken pipes were identified as priorities after engaging with that sector. They are somewhat spread out in connection to locations of drinking water and sewage treatment plants, and sites of water pipe maintenance, replacement and upgrade activity. It is almost certain that similar waste stockpiles and streams arise from other industrial sectors operating across the state, however these sectors may not have been engaged with due to project scope limitations.

The MRF residues containing glass are a complex mixture of materials that arise from kerbside recycling sorting activity, that have not been actively sorted and set aside either as a contaminant or as a usable resource. While glass is a major component, this stream effectively includes everything else that the MRF was unsuccessful in removing, as the commingled recycling passes its way through the facility. The presence of the non-glass material impairs the value of this stream as a recycled input for future use in glass manufacturing, or as a material that may substitute for aggregate or sand used in civil engineering projects.

Construction & demolition spoil dumps and concrete waste from water utility assets

According to TasWater, there is a volume of construction and demolition waste that has been generated and potentially accumulated across drinking water and sewage treatment plants and other water utility sites. The prevailing practice over the water utility's longer history (i.e. over many decades) has led to some remaining spoil heaps across the state. Over time, some waste piles had been managed offsite (disposal) or reworked into the landscape through periodic backfilling activity. These historic volumes may be a mixture of rubble, masonry, concrete, scrap metal, glass and other construction and demolition material. Soils may be intermingled with this spoil, which could include contaminated soil, depending onsite history.

TasWater advises that works that take place at these sites may continue to involve a level of onsite backfilling, which may involve some of the spoil as fill material on an ad hoc and opportunistic basis. However, this practice does not generally activate a more general spoil remediation process. It was also disclosed that, for site works on other properties, TasWater purchases and has fill material brought onto the site using commercial suppliers. This combination of practices suggests an opportunity for the more efficient use of accumulated inert material, which may be available for use across multiple water utility sites.

The water sector also generates inert waste during new maintenance and upgrade projects, and has sought to recycle this waste where possible. This is generally more viable in southern parts of the state where there is evidently a more developed construction and demolition waste recycling sector. A lack of capacity in the north of the state has led TasWater to dispose of some

recyclable materials in landfill. In general, TasWater does not generate and stockpile new inert construction and demolition wastes onsite, and instead manages via offsite facilities (with recycling preferred when available).

Obsolete and broken pipes made of concrete, plastic or galvanised iron

The water sector has also brought attention to old and broken water pipes made of concrete, plastic and galvanised iron, that have been left as piles associated with water network maintenance, replacement and upgrade projects. It is understood that this stream represents a smaller volume of waste than the above spoil and concrete waste, and much of this material may have arisen and accumulated during the previous era involving local water authorities. To the extent that these wastes are taken offsite, the typical destination involves landfill disposal.

As the volumes are relatively modest and dispersed compared to other priority industrial streams generated across Tasmania, it may be challenging to drive investment in solutions for recycling concrete, plastic and galvanised iron water pipes in their own right. However, the development of recovery supply chains for other priority plastic, concrete, and metal waste streams may provide a suitable avenue for recovering water pipe waste as well.

MRF residues containing glass impacted by impurities

While kerbside commingled recycling is technically a form of municipal solid waste (MSW), the residual waste that is left from sorting and removing saleable resources from commingled recycling is actually an industrial waste.

The presence of metals, paper and plastics of different colours may impair applications for recycled glass where appearances matter, while the presence of metal contaminants may affect some options to mechanically crush the material into a fine sand substitute. A level of plastic contamination also impedes the use of this material in civil applications, as it essentially contributes to the dispersal of microplastics through the environment.

The removal of foreign non-glass items from these stockpiles and future MRF residue streams would open up the opportunity for use in a range of applications. Depending on the technology in question, there may also be the potential to sort the glass by colour, which may lead to further increases in economic value.

Potential solutions for inert aggregates

Construction & demolition spoil dumps and concrete waste from water utility assets

The recycling of inert construction and demolition waste including concrete waste is well established across different parts of Australia (including in southern Tasmania), where the process typically involves a workflow of sorting into different materials, transport to a recovery facility, and then crushing and screening bricks, masonry and concrete to produce aggregate of different sizing grades. The product is often used as road base and pipe bedding material.

These products may substitute for sand, grit, gravel and other bulk commodities extracted from quarries and pits. In some cases, the crushing can take place using mobile equipment if the expense can be justified through having a large volume to process, and/or through being able to use the product onsite (e.g. during brownfield development or site upgrade projects).

The increased recovery of inert waste including concrete waste from water utility sites rests upon new investment in construction and demolition waste processing infrastructure, particularly in northern Tasmania.

A number of factors may need to be resolved to ensure that it is economical to recycle construction and demolition waste dispersed across water utility premises in the north. These factors may be addressed through a workflow that:

- Characterises and prioritises water management sites according to the quantity, location, and types of waste found in spoil heaps and likely to arise from planned works, along with the sensitivity of local surroundings to the continued presence of these streams
- Tests and assesses the waste for contaminated soil, where there are grounds to suspect that there may be contamination according to site history
- Flags higher priority sites for C&D waste remediation, ideally to coincide with or following on from other works planned at that site that may use some as backfill material
- Engages a contractor to: sort the waste according to usable resources; move to a suitable location for recycling or temporary storage; recycle via crushing and screening; and then make a volume potentially available for future water utility maintenance and development projects.

Depending on the distribution and volume of waste, it may be most economical to take the relevant materials to an interim location, and then recycle using mobile equipment on a batchwise basis. Alternatively, the spoil could be taken directly to a dedicated stationary recycling plant in Launceston or elsewhere. The potential role of the water sector to both supply waste material and then purchase aggregate for future needs may enable the utility to encourage competitive pricing from recycling service providers, while ensuring that existing spoil stockpiles are used efficiently in preference to purchasing virgin backfill material.

Obsolete and broken pipes made of concrete, plastic or galvanised iron

The broken pipes that have historically and are currently being generated by water network maintenance, replacement and upgrade activity may represent a small proportion of concrete, plastic and metal industrial waste, compared with similar streams in other industries. It is likely that improved recycling of these materials will in part rest on the establishment of recycling capacity – especially in industrial plastic and concrete processing – towards the state's north.

The efficient mapping, consolidation and transport of water pipe wastes to their respective recycling points for recycling different materials is an additional consideration. A suitable process may involve planning for and executing backhauling activities from waste sites to recycling centres synchronised with other heavy transport activities undertaken in the water sector.

MRF residues containing glass impacted by impurities

The refinement of impure glass produced by MRFs can take place in a glass beneficiation plant, which is designed to remove magnetic and low density objects from a glass mixture, while also removing labels and other attached items. Beneficiation plants can be set up as an inline module at a recycling facility or may potentially be operated as a stand alone set of equipment.

Depending on the market conditions and commercial opportunities at hand, the recovered glass may be used as an input to remanufacture glass packaging, or alternatively it may be used as an aggregate (i.e. as a substitute for sand or gravel in pipe beds or road base applications).

The Queensland Government provides an example workflow for use of a beneficiation plant as follows, noting that different plants may use a variation on this set up.[23]

- Delivered glass is loaded into a bottle breaker unit, which crushes the glass down into pieces that are smaller than 25mm.
- The glass travels beneath a magnet which removes ferrous metals, before entering a de-labelling drum, which removes labels that are still attached to the glass.
- The glass is sorted into different sizes through a rotating trommel screen. Glass pieces that are too large are returned to the start of the process, while the rest are further purified by jets of compressed air that remove any non-glass debris.
- The decontaminated and crushed glass is then transported to another crusher, where is it ground down into pieces less than 5mm – the desired size of glass sand.
- A final screen is used to filter the glass by size once more, and then it is ready for storage ahead of different applications as a sand replacement.

In Tasmania, there may be opportunity to invest in and fit out one or more beneficiation units attached to MRFs in the north and south of the state. Alternatively, it may be more suitable to encourage investment in a facility that processes glass packaging produced by MRFs and collected through the Recycle Rewards Scheme. In part, the preferred arrangement may depend on whichever option provides the greatest economies of scale given the limited quantities of glass produced in Tasmania. In other states, glass beneficiation plants operated by Visy, Orora and Kriaris Recycling (as examples) sort as little as 7,000 tonnes and as much as 200,000 tonnes of glass per year.

Material flows and supply chains

In the diagram below (Figure 9), an indicative workflow for the three streams of industrial waste in this category are shown. In the case of water pipe waste, the direction for recovery is largely governed by its composition (plastic, metal or concrete) and whether there is a need to remove soil, dirt and other residues prior to being passed through a recycling facility.

[23] https://www.statedevelopment.qld.gov.au/news-and-events/friends-with-beneficiates-turning-waste-glass-into-new-roads

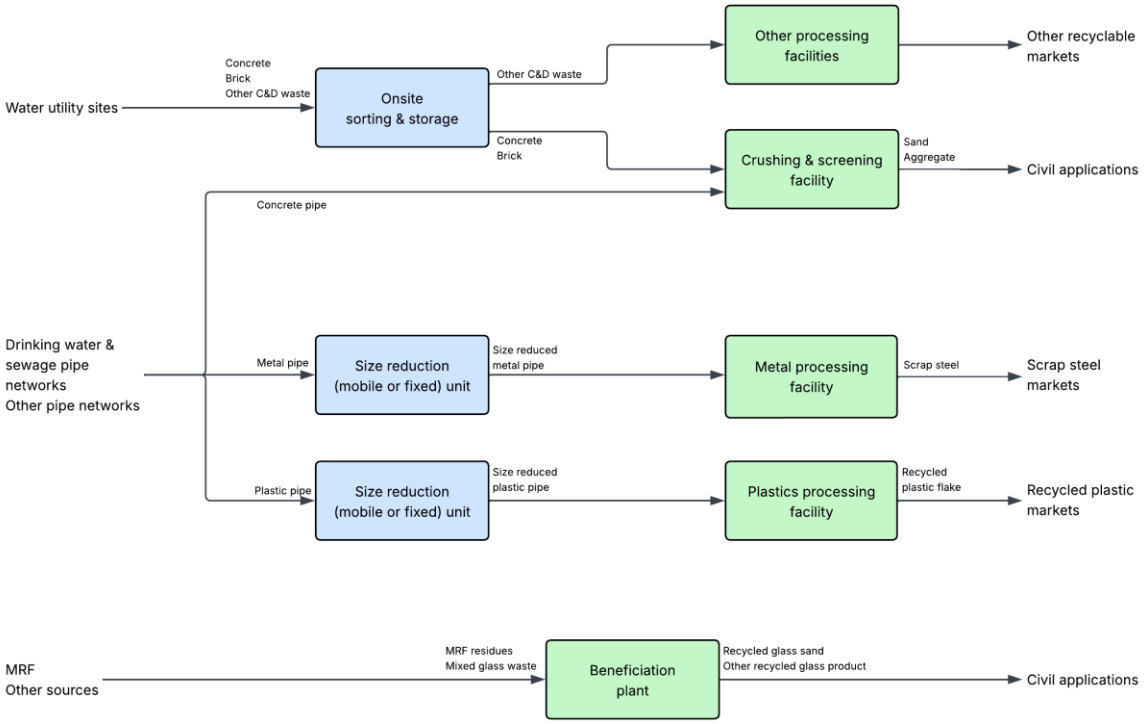

Figure 9: Potential configuration of operations to recover inert construction and demolition waste (including concrete waste from water utility sites), waterpipe waste made of various materials, and glass from mixed MRF residues. In the case of waterpipe recycling, it is likely that the water sector would need to rely on recycling infrastructure whose development was driven by the opportunity to recycle from other industries, due to limited levels of pipe waste being generated in a given period. Similarly, opportunities to recycle water sector construction and demolition waste in the north of Tasmania may depend on the establishment of concrete and brick crushing and screening capacity, driven by volumes of material arising from the construction sector (e.g. spanning residential, commercial and public infrastructure works).

Action recommendations

Construction & demolition spoil dumps and concrete waste originating on water utility assets

Obsolete and broken water pipes made of concrete, plastic or galvanised iron

Priority stream	ANZSIC Industry	Other industries	Solution(s)
Construction & demolition spoil dumps and concrete waste originating on water utility assets	D – Water utilities	Construction Other utility networks	Separation of C&D wastes according to material type and, if relevant, presence of contamination. Crushing and screening for materials suitable for use as inert aggregate, i.e. using mobile equipment or fixed location facilities.
Obsolete and broken water pipes made of concrete, plastic or galvanised iron	D – Water utilities	Construction Other civil infrastructure	Separate treatment of pipes according material type, e.g. concrete, plastic or metal. Process using established mechanical recycling technologies for each type of material. Clean up or size reduction may be necessary prior to processing.

Action	Action area	Lead organisation(s)
Engage with the Tasmanian water sector on mapping and characterising accumulated and emerging C&D waste (including concrete stockpiles) and drinking water and sewage pipe wastes across its asset footprint, using the results to: • Prioritise water asset sites for contamination testing, recovery and remediation. • Develop a waste recovery plan for water sector C&D waste and pipe waste (plus other wastes as may be agreed as relevant). Note: Engagement with other sectors that generate C&D waste and pipe waste may be suitable, to uncover potential economies of scale and scope in pipe waste recovery and C&D waste recovery (particularly in northern Tasmania).	Engagement & brokering Spatial mapping & infrastructure planning	WRR Board TasWater ITas
Confirm gaps in C&D recovery infrastructure in the north – noting that the viability of this infrastructure will in part rest on the level of demand from the water sector and other sectors that generate C&D waste. Provide funding support to address these gaps and encourage recovery of C&D waste, and metals, plastics and concrete from broken and replaced pipes.	Support for local commercialisation & investment	WRR Board ITas

Materials Recovery Facility residues containing glass impacted by impurities

Priority stream	**ANZSIC Industry**	**Other industries**	**Solution(s)**
Materials Recovery Facility residues containing glass impacted by impurities	D – Waste & recycling	N/A	Separation of glass from impurities using glass beneficiation plant. Crushing and use of glass as a sand or aggregate replacement in civil applications.

Action	Action area	Lead organisation(s)
Undertake a volume projection for glass packaging recovery from MRFs, the Recycle Rewards Scheme, and other sources to determine whether projections can sustain investment in an appropriately sized and located glass beneficiation plant. This study should include consideration of potential end markets in Tasmania (preferred) and other locations, noting the low commodity value and high transport cost that typifies this resource stream.	Spatial mapping & infrastructure planning	WRR Board
Pending results from above volume projection analysis and identified undercapacity in glass purification / refining, contribute funding to glass beneficiation plant to remove impurities from multiple glass streams.	Support for local commercialisation & investment	WRR Board

5.3 Streams requiring innovation towards novel recovery paths

Group 4: High moisture content industrial wastes

- *Alum sludge used in treating drinking water*
- *Biosolids generated by sewage treatment*

Alum sludge and biosolids are waste streams that are inherent to modern water treatment technologies. In the current water treatment practices used in Tasmania, these waste streams retain high water levels, with the solid content mainly taking the form of a major constituent (e.g. alum, biosolids) along with minor concentrations of other substances intentionally or inadvertently entrapped during water treatment.

Alum sludge used in treating drinking water

Alum sludge occurs from the addition of aluminium sulfate ('alum') to water in preparation for use as drinking water, where it removes trace impurities and improves clarity. TasWater has disclosed that the main constituent of alum sludge is water (80% moisture content or more), followed by suspended solids including alum and other materials separated from drinking water. TasWater will typically allow the sludge to passively dry out to render it spadable, so that it may be disposed of in a landfill permitted to receive water treatment sludges.

The alum sludge is generated across TasWater's drinking water treatment plants, on a batchwise basis. This means that the material is somewhat dispersed throughout the state, and is somewhat inconsistent in its rate of generation.

Biosolids generated by sewage treatment

Biosolids are an ongoing waste stream that occurs as a result of the treatment of sewage water with microbes, to break down organic pollutants that will otherwise enter the environment at levels that are deemed unsafe, and that may breach standards for the release of effluent from sewage plants. Biosolids may therefore be seen as an accumulated mass of microbial matter and retained water. Biosolids contain organic carbon and soil nutrients including potassium and nitrogen plus a range of micro-nutrients. They can play a role in improving soil health while displacing the demand for manufactured fertilisers.

Biosolids may contain a range of contaminants that reflect different points of origin of sewage water. Depending on the water's sources, these contaminants may be relatively benign, but there may be cases where biosolids contain heavy metals, PFAS, micro-plastics, pharmaceuticals and personal care products and their metabolites, pathogens or other pollutants.

While biosolids had traditionally been deposited in landfills, there is a growing tendency to reuse biosolids in composts and/or in land spreading applications. TasWater tests its biosolids to determine the level of key contaminants (as set out in EPA guidance) before land spreading or composting.[24] Any biosolids that are assessed to contain high levels of contaminants are sent to the Copping Category C cell for disposal.

According to TasWater's *Environmental Performance Report 2023-24*, 53,765 tonnes of biosolids were generated in that year, which were managed in the following ways:[25]

[24] EPA Tasmania, *Tasmanian biosolids reuse guidelines*, 2020.
[25] TasWater, *Environmental Performance Report 2023-24*, p.18-19.

- Direct agricultural application (also known as land spreading) – 43,819 tonnes (81.5%)
- Composting – 9,794 tonnes (18.2%)
- Site rehabilitation – 50 tonnes (0.1%)
- Disposal to landfill – 102 tonnes (0.2%)

TasWater has expressed the view that the practice of land spreading biosolids represents a relatively low level form of recovery with uncertain benefits, and that more suitable, higher value alternatives may be worth investigating and putting into practice. There is the additional concern that land spreading does not involve removing or eliminating pollutants in the biosolids that may be present, whose levels fall below a given safety threshold or whose levels fall below the levels of detection specific to accredited techniques in quantitative analysis.

Alternative options that destroy or immobilise contaminants, or that place the biosolids in an environment that is less sensitive than productive agricultural land, may be viewed as preferred practice. Thus, even though the above listed management practices only involve a modest degree of landfill disposal, TasWater is actively progressing a biosolids roadmap to unlock new solutions involving the sustainable use of biosolid materials.[26]

Potential solutions for high water content industrial wastes

A number of recovery alternatives for biosolids (i.e. beyond disposal or direct land spreading) are starting to become more common across the water sector in Australia, although these do not yet appear to have consolidated into a standard set of methods. In part, this is because different states have their own regulatory regime for what is acceptable for land application, and are also in different stages of progress for examining and dealing with potential risks to productive agricultural land. Micro-plastics[27] and PFAS contamination[28] concerns are two general areas where the industry has been trying to navigate and resolve a series of issues.

The reuse and recycling of alum sludge is less technologically and commercially developed in Australia compared to biosolids, although a number of trials involving civil engineering and land contouring applications are being explored and are reported on below.

Across the alternatives to existing practices for managing biosolids and alum sludge, there appears a common requirement to reduce the amount of water bound within these waste streams. TasWater has acknowledged that, for each stream, the water content is passively reduced, but only to a sufficient degree of dryness to render the material spadable. This may involve a retained water content of up to 85% of the total mass. Depending on the recovery applications in question, these streams may need to be dried to a water content of below 25%.

Several dewatering technologies are commercially offered in Australia and include as examples:

- Passive air drying (with periodic turning to expose high water content volumes)
- Capture and drainage / evaporation through geotextile bags

[26] https://smartwatermagazine.com/news/taswater/taswater-leads-way-sustainable-biosolids-management
[27] S. Ziajahromi *et al.*, 'Comprehensive assessment of microplastics in Australian biosolids: Abundance, seasonal variation and potential transport to agroecosystems,' *Water Research*, Volume 250, 2024, 121071.
[28] https://www.biosolids.com.au/wp-content/uploads/ANZBP-PFAS-Biosolids-Factsheet-1.pdf

- Pumping through centrifuge (e.g. for smaller footprint sites)
- Passage through belt press or spiral press
- Solar assisted drying (with periodic turning).

Irrespective of a future circular economy approach to biosolids and alum sludge generated by water treatment activities, some level of investment in one or more of these technologies is likely to be necessary. The merits of investment in dewatering equipment may arise from its function in preparing biosolid and alum sludge wastes for recovery processes that take place downstream. But the technology may also function to lower waste transport costs and reduce gate fees in the event that the stream must be taken to a landfill during times when no other option is available (e.g. due to recovery interruptions or high pollutant loadings).

Emerging solutions for alum sludge recovery

On the Australian mainland, a number of water authorities have explored alum sludge recovery trials. This follows on from a wider body of literature into reuse opportunities that has been developed, both in Australia and overseas.[29, 30]

Using samples provided by South Australian Water, alum sludge was trialled as a partial substitute (at 10%) for sand in concrete block manufacturing in 2023. After testing durability, strength, reactivity and leaching performances, it was found that alum sludge containing cement blocks could substitute for conventional concrete blocks used in non-load bearing applications. Carbon dioxide curing results in a cement block with enhanced compressive strength, suggesting that alum sludge concrete blocks could substitute for conventional load-bearing blocks.[31]

While the likely scale of the concrete blocks market in Tasmania and mainland Australia may lend optimism to this application for alum sludge waste, a key challenge is that the Tasmanian water sector produces alum sludge on an occasional, batchwise basis. This may make it difficult to introduce alum sludge into concrete block production workflows, and accelerate its uptake.

Gippsland Water in regional Victoria is testing the blending of alum sludge with gravel to create a new pavement material, which is intended to bear the weight of heavy vehicles traffic.[32] While the formulation is yet to be field tested, Gippsland Water envisages that once the pavement is optimised, it would be used to be build and maintain its internal road networks. This reuse application has the benefit of being entirely within the boundaries of the waste authority's own operations, i.e. it involves limited requirements to work with other businesses and industries' business models, workflows and change management protocols.

In Tasmania, TasWater has expressed an interest in exploring the use of alum sludge mixed with compost as a backfill material given its current extensive purchasing of backfill (see description under construction and demolition waste generated by the water sector in Section 5.2) associated with maintenance and upgrade projects. Again, this approach has the benefit of being a reuse application that takes place wholly internal to TasWater operations.

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[29] M. D. Nguyen *et al.*, 'Beneficial reuse of water treatment sludge in the context of circular economy,' *Environmental Technology & Innovation*, Volume 28, 2022, 102651.
[30] https://www.wannonwater.com.au/wp-content/uploads/2025/04/Alum-Use-in-the-Victorian-Water-Sector-Report.pdf
[31] https://info.awa.asn.au/water-e-journal/how-co2-curing-can-turn-alum-sludge-into-construction-material
[32] https://www.gippswater.com.au/about-us/news/media-news/sludge-paves-way-sustainable-construction

From the above, the more immediate opportunities for recovering or reusing alum sludge from the water sector include mixing with gravel as a pavement formulation, and potentially, mixing with compost to produce a suitable backfill. While other applications may emerge in time, these may work as near term prospects that leverage existing research occurring on the Australian mainland. However, given their potential uses on and within soils across Tasmania, there will need to be a suitably rigorous framework for preparing and testing relevant formulations.

Emerging solutions for biosolids recovery

TasWater has mainly been directly sending its biosolid waste to agricultural land parcels in a land spreading practice, with some biosolids also being used in composting operations. Biosolids contaminated with heavy metals or PFAS have instead been disposed of in a Category C landfill, and this activity is an exception rather than the norm (due to the general absence of such contamination).

An online review of emerging options to manage biosolids suggests that the main area of innovation involves various thermal breakdown technologies. These processes involve heating the biosolids in an oxygen depleted environment, with the technologies variously categorised as pyrolysis and gasification technologies, depending on the conditions used. In general, the energy liberated from the waste material during thermal breakdown is sufficient to maintain the high temperature reaction environment. Depending on the reaction conditions, other products include a low grade oil, solid tarry residues and/or inorganic solid carbon ('biochar').

There are also some examples of optimising biosolids land application through revised drying and maturing protocols, and then actively working the matured biosolids into the soil. These seems to be an evolution of existing land spreading practices, rather than a new field of biosolids recovery, and will not be explored further below.

The pyrolysis or gasification based treatment, in producing an inorganic biochar product, may unlock a range of further applications in energy production or soil improvement.

One of the advantages of this recovery pathway is that, depending on the operating conditions, the heat required to cause the thermal breakdown of biosolids has been shown to destroy micro-plastics and PFAS residues contained within the biosolid mass. Any heavy metals bonded to or trapped within the biosolids matrix will remain, although may become immobilised within a porous carbon matrix. [33]

A 2018 review of biosolids treatment using pyrolysis explores different reaction conditions, products, and their potential applications.[34] In late 2024, a techno-economic analysis of biosolids pyrolysis was published, investigating its effectiveness in eliminating microplastics, PFAS and pharmaceuticals and chemicals from personal care products.[35] These reports suggest a growing and credible body of scientific evidence on the use of thermal breakdown technologies to treat and prepare biosolids waste for a range of applications.

A recent Australian development in biosolids pyrolysis involves a partnership with RMIT University, Greater Western Water and South East Water (regional Victorian water authorities).[36]

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[33] S. Aktar *et al.*, 'Immobilization of Heavy Metals in Biochar Derived from Biosolids: Effect of Temperature and Carrier Gas,' *Soil Systems*, Volume 8(4), 2024, p.117.
[34] J. Paz-Ferreiro *et al.*, 'Biochar from Biosolids Pyrolysis: A Review,' *International Journal of Environmental Research and Public Health*, Volume 15(5), 2018, p.956.
[35] https://www.sciencedirect.com/science/article/pii/S0048969724049222
[36] https://www.rmit.edu.au/news/all-news/2021/jul/biosolids-tech-trial

RMIT University's patented PYROCO technology heats biosolids to 600°C and is claimed to be able to destroy PFAS, residual pharmaceuticals, and pesticides contained in a biosolids sample.

This process would render the resulting biochar more suitable for land application than untreated biosolids that contain these pollutants. Gases and oils released during the biosolid breakdown provide the energy needed to sustain the required temperatures, thereby lowering the carbon footprint and cost of this process.

The technology is designed to be mobile and modular, to enable use by smaller scale and more regional water authorities. It is understood that South East Water has recently commissioned a PYROCO demonstration plant to process up to 3,000 tonnes of dewatered biosolids (i.e. dewatered to 50% solids) per year, and produce up to 650 tonnes of biochar.[37] A technical description of the process has been published online via the Australian Water Association.[38]

A similar development is taking place at the larger end of the technology scale, with Sydney Water investing in two German-made biosolids pyrolysis units from Pyreg to process all of its biosolids from the Riverstone Treatment Plant.[39] These units are projected to convert 10 tonnes dry weight of biosolids per day into biochar (i.e. 20 tonnes per day at 50% moisture level or.

Other Australian teams have developed biomass pyrolysis technologies that are designed to produce biochar from a wider range of inputs, rather than the narrower focus on biosolids as described above.[40] These technologies gain some flexibility at the potential expense of efficiency and optimisation towards biosolids, which may bring the advantage of being able to service multiple industries that generate a range of waste streams in Tasmania.

As a separate development, engagement with Abel Energy over the course of this project suggests emerging demand for biomass, potentially including dewatered biosolids, for the manufacture of green methanol. Near term opportunities may include large scale green methanol projects under development at Bell Bay[41] and Burnie.[42] However, these opportunities are entirely reliant on the progress and success of these projects.

The above paragraphs suggest substantial technical and commercial progression of biosolids pyrolysis technologies, which is highly applicable to the Tasmanian water sector context. At the very least, there may be benefit in continuing to follow these developments and potentially seek interest in a Tasmanian collaboration (e.g. demonstration and field trials using Tasmanian biosolid feedstocks and land application).

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[37] https://iotaservices.com.au/project/new-australian-pyrolysis-technology-delivers-breakthrough-in-biosolid-to-biochar-conversion/
[38] https://info.awa.asn.au/water-e-journal/thermal-treatment-of-south-east-water-biosolids-to-solve-disposal-challenges
[3939] https://www.aquatechtrade.com/news/circular-economy/pyreg-installs-its-largest-plant-to-date-for-sydney-water
[4040] https://thecharmaker.com/our-technology/our-technology/
[41] https://abelenergy.com.au/faqs
[42] https://hifglobal.com/locations/tasmania

Characterisation of solutions

Table 5: Emerging solutions for alum sludge recovery

Waste stream: Alum sludge	**Solution: Sand replacement in concrete blocks**
Technology readiness level	TRL 5 – Laboratory scale validation of concrete performance
Technical & organisational simplicity to integrate workflows	May require additional equipment and workflows to dewater sludge prior to use in concrete block fabrication. The concrete block sector may also struggle to optimise their use of alum sludge given its intermittent production.
Operational scale compatibility	Concrete block fabrication is highly scalable, suggesting likely ability to work alum sludge into block manufacturing batches.
Operating risks pertinent to adoption	As yet, performance levels and market demand for concrete blocks using alum sludge are not well understood.
Technology limitations	The research thus far does not give evidence that alum sludge concrete blocks are suitable for load bearing applications, which may restrict uses to ornamental, cladding and/or traffic management applications.
Logistical and handling requirements	Dewatering is likely to be a necessary first step for this application, which requires alum sludge from various water treatment plants to be sent to one or more dewatering centres. The dewatered sludge would then need to go to a concrete block manufacturing facility, adding to transport costs.
Compatibility with existing regulatory settings	No inherent challenges regarding regulation but there may be standards and specifications for formulating and using concretes in different applications.
Social licence considerations	Solution may attract a positive social licence, given reduction in alum sludge volumes and reduced demand for cement sand.
Waste stream: Alum sludge	**Solution: Blending with gravel as a pavement material**
Technology readiness level	TRL 6 - Engineering prototype tested in a relevant environment.
Technical & organisational simplicity to integrate workflows	May require additional equipment and workflows to dewater sludge prior to blending with gravel as an internal pavement.
Operational scale compatibility	Pavement mixing and laying can be performed using fixed or smaller scale mobile plant, which is compatible with sludge.
Operating risks pertinent to adoption	This may be a solution with lower risks based on TasWater potentially being able to use the pavement on its internal road networks (i.e. does not need to stimulate external demand).
Technology limitations	There may be limitations on the type of ground conditions and/or traffic load, which may need to be tested and validated.
Logistical and handling requirements	Dewatering is likely to be a necessary first step for this application, which requires alum sludge from various water treatment plans to be sent to one or more dewatering centres. However pavement blending could potentially be co-located or dewatered sludge could be backhauled to where needed.
Compatibility with existing regulatory settings	No inherent challenges regarding regulation but there may be standards and specifications for formulating and using novel pavements in different applications.
Social licence considerations	Solution may attract a positive social licence, given reduction in alum sludge volumes and reduced demand for virgin aggregate.

Waste stream: Alum sludge	Solution: Blending with compost as a backfill material
Technology readiness level	*Unknown* – no precedent examples of research or development were uncovered during the project.
Technical & organisational simplicity to integrate workflows	May require additional equipment and workflows to dewater sludge prior to blending with compost.
Operational scale compatibility	Composting can be performed on a wide variety of scales which may be compatible with outputs of alum sludge. Demand for backfilling likely to be more than adequate for sludge reuse.
Operating risks pertinent to adoption	Acceptance of alum sludge / compost may need to be satisfied that there is no risk of soil contamination, leaching, odour etc.
Technology limitations	Assuming minimal impacts due to contamination or odour from the backfill material, likely to be few limitations to the use of alum sludge / compost backfill.
Logistical and handling requirements	Dewatering is likely to be a necessary first step for this application, which requires alum sludge from various water treatment plans to be sent to one or more dewatering centres. Compost blending may potentially be co-located and may require odour controls.
Compatibility with existing regulatory settings	No inherent challenges regarding regulation but there may be standards and specifications for formulating and using compost mixes in different applications. Separate permit may be required if TasWater produces its own compost material.
Social licence considerations	Solution may attract a positive social licence, given reduction in alum sludge volumes and beneficial use of compost. Consultation with communities may be needed to confirm no risks to soil quality, amenity effects etc.

Table 6: Emerging solutions for biosolids recovery

Waste stream: Biosolids	Solution: Thermal breakdown to produce biochar
Technology readiness level	TRL 8 – Actual system completed and qualified through testing and demonstration (in NSW and Victoria)
Technical & organisational simplicity to integrate workflows	Precedents suggest that dewatering to 50% solids may be necessary prior to feeding into a pyrolysis unit. There may be additional challenges in integrating biochar product into one or more applications downstream of pyrolysis.
Operational scale compatibility	The prior examples in Victoria and NSW suggest that biosolids pyrolysis is modular, scalable and somewhat mobile; and may work at a scale suitable for Tasmania's biosolids output.
Operating risks pertinent to adoption	It is likely that a suitable testing program is needed to confirm that these technologies adequately deal with PFAS, microplastics and other thermally destructible contaminants, before achieving acceptance for biochar in selected applications (most notably any land application).
Technology limitations	The pyrolysis technologies may not be effective in addressing inorganic contaminants (e.g. heavy metals), which may preclude their use in recovering metal contaminated biosolids.
Logistical and handling requirements	Biosolids dewatering may be required to reduce moisture levels to 50%, and pyrolysis units may be co-located with a dewatering facility.

Compatibility with existing regulatory settings	Permits may be required for the commissioning and use of a pyrolysis facility, along with permits with testing conditions for the application of biochar to different purposes.
Social licence considerations	If the proposed solution can clearly demonstrate the removal of PFAS and other chemicals of concern ahead of e.g. land application, there is potential that this solution will be well received by the community.

Action recommendations

Alum sludge used in drinking water treatment

Priority stream	**ANZSIC Industry**	**Other industries**	**Solution(s)**	
Alum sludge used in drinking water treatment	D – Water utilities	N/A	Solutions are presently emerging, and may include the following: • Use as a sand replacement in concrete blocks • Blending with gravel in pavement applications, potentially used on water utility property roads • Blending with compost for use in land contouring and backfilling Dewatering to lower moisture content may be a pretreatment necessary for each of the above treatment processes.	
Action			Action area	Lead organisation(s)
Support to TasWater and partners to perform pilot scale research projects, in the use of dewatered alum sludge blended with other inputs, as a pavement or backfilling mixture used in one or more TasWater sites. Include a wider analysis of potential sites of application (i.e. beyond TasWater assets). Consider dewatered hydro-excavation sludge and/or timber industry boiler ash with low contaminant loadings as potential inputs (i.e. as variant formulations) in pavement blends; and biosolids as an input to backfilling mixtures.			Support for local commercialisation & investment	WRR Board TasWater
Pending outcomes from the above projects, co-fund alum sludge dewatering and other technologies to deliver long term reuse/recovery solutions for alum sludge. Where relevant, these technologies may also apply to biosolids recovery, hydro-excavation sludge recovery and boiler ash recovery.			Support for local commercialisation & investment	WRR Board

Biosolids generated by sewage treatment (mainly organic but may have inorganic loading)

Priority stream	ANZSIC Industry	Other industries	Solution(s)
Biosolids generated by sewage treatment (mainly organic but may have inorganic loading)	D – Water utilities		Solutions beyond some land spreading and composting are emerging, including the following: • Pyrolysis to destroy plastics, PFAS and other synthetic contaminants, with resulting biochar used in soil improvement applications, composting, or other uses. Dewatering to lower moisture content to below 50 % may be a pretreatment necessary for pyrolysis or other treatment processes.

Action	Action area	Lead organisation(s)
Fund a business case that investigates different biosolids thermal breakdown technologies and their application to Tasmanian biosolids, and the potential use of biochar products in different end markets (e.g. soil improvement, composting, other). This business case may cover requirements for dewatering biosolids prior to use in a thermal breakdown chamber, and compare against other reuse alternatives including land spreading and addition to commercial compost blends.	Support for local commercialisation & investment	WRR Board TasWater
Pending outcomes from the above investigations, co-fund dewatering, compost formulation and blending, and/or thermal breakdown (e.g. pyrolysis) technologies to deliver long term reuse/recovery solutions for water treatment biosolids. Where relevant, these technologies may also apply to alum sludge recovery.	Support for local commercialisation & investment	WRR Board

Group 5: Metal processing byproducts and processing residues

- *Byproduct from metal smelting, refining & alloying*
- *Damaged / worn heavy duty machinery & equipment used in metal smelting, refining & alloying*

The industrial streams in this category generally refer to the byproducts produced when smelting, refining or otherwise processing metal commodities; and heavy machinery and equipment that becomes damaged or worn as part of these processing activities. The waste streams in question are highly specific to individual production processes, and may involve unique chemistries and/or materials that are substantially coated, impregnated or otherwise contaminated with process-specific chemical and/or metallurgical residues.

The waste streams may be characteristic of the long term operations of a given facility or may arise in large volumes over short and intensive periods associated with plant and equipment replacement and upgrades, decommissioning works, new process trials and optimisation experiments, and/or site maintenance and clean up operations.

Yet because they are mainly produced from tightly specified and controlled production processes, conditions and inputs, the compositional, physical and mechanical characteristics of each batch of waste within a defined stream should be somewhat consistent and predictable.

For some wastes that fit with this grouping, recovery options and end applications will be both novel and niche, and may require substantial testing for efficacy, commercial efficiency, repeatability, and above all, safety. There may also be issues related to maintaining broad compliance with controlled waste requirements and environmental permit conditions, while also providing a limited and controlled space for testing and optimising a range of recovery solutions that meet the various partners' due diligence and risk management standards. By their nature, these streams may be unlikely to be compatible with general purpose recycling set ups that handle materials from general commercial and domestic activities, yet efforts to uncover new solutions may interact with a range of environmental protection provisions for controlled wastes.

Byproduct from metal smelting, refining and alloying

Due to the incomplete transformation of ores and unrefined metals into commodity grade products, metal refining and processing may produce large quantities of dross, slag, off-spec product and other byproducts that may be captured as sludge cakes, ash and sweepings.

The byproduct may be chemically inert or reactive, and its chemical and physical properties may alter over time through slow curing processes, reaction with ambient air and moisture, and or leaching processes. In general, metal processing byproducts may involve a complex mixture of retained metal (in elemental, ionic or complex states), oxide and halide salts, silicates, and other materials that are technically and commercially impractical to separate into useful products.

Engagement with and examination of public reports from the metals sector suggest that key byproduct generated in large volumes in Tasmania is a silicon-manganese slag generated from ferromanganese alloy manufacturing. The current stockpile of this material, located on the Liberty Bell Bay smelting site, is estimated to have accumulated to 70,000 to 100,000 tonnes.

Damaged / worn heavy duty machinery & equipment used in metal smelting, refining & alloying

The harsh operating environments involved in metal manufacturing inevitably leads to the wearing, degradation, corrosion and contamination of heavy duty plant, equipment and consumables. For a range of reasons, some of these end of life items cannot easily be disposed of through general purpose equipment and scrap metal recycling supply chains.

However, there have been instances of successful recycling and/or energy recovery, where the focus has been on collaborative trials involving metals sector waste generator(s), recovery technology leads, and industrial end customers. Examples include Bell Bay Aluminium sending spent cell lining to Cement Australia's Railton cement kiln as an alternative fuel, along with waste bricks and alumina that are crushed for use as a material input to the concrete product. But over time, it is likely that new equipment waste streams will be generated, where solutions will need to be explored on a case by case basis.

Potential solutions for metal processing byproducts and processing residues

Emerging solutions for byproduct from metal smelting, refining and alloying

The above descriptions suggest that silicon-manganese slag is a major volume of byproduct that requires a management solution. A solution for this stream will need to meet a number of technical and commercial performance levels, and needs to involve end markets that can absorb the quantity in question and involve costs that fit within the tolerances of the waste generator as a liable party (i.e. compared with disposal options that it may be able to implement while meeting compliance requirements).

Other metal processing byproducts may emerge as a concern over future years, yet it is challenging to put forward specific recovery pathways without a firm understanding of these byproducts' compositions and volumes. Instead, it may be more useful to set out a framework for investigating, validating and commercialising innovative recovery pathways, which is broadly applicable for byproducts that are yet to be identified and characterised.

This framework would need to satisfy the risk management and due diligence protocols of involved partners as well as any public entities that carry a duty of care for e.g. environment protection, workplace safety, management of public land, and delivery of essential services that may be affected during testing and final implementation stages. This is explored further below.

Returning to the more immediate silicon-manganese slag byproduct, a number of explorations at the research and development stage are evident in the literature. These have included for example, the use of different types of slag (mainly focused on iron and steel slag) in road base and rail ballast, as well as in concrete and civil aggregate applications.[43] A precedent in the use of iron smelting slag in road applications and concrete applications is now established in Australia, although this does not extend to silicon-manganese slag as yet.[44]

In short, while there is extensive literature on reuse and recycling of slag, the vast majority of research is dedicated to iron and steel slag applications. The findings from these bodies of work cannot be simply extrapolated to silicon-manganese slag due to different physical and chemical characteristics, particularly given the potential for manganese to leach into and negatively impact the environment under certain conditions.

In 2024, a Malaysia-based Swinburne University team completed a detailed review of academic literature, centring on silicon-manganese slag recovery. This work spanned a compositional analysis of silicon-manganese slags, and a review of reuse options that were published from 2005 through to 2024. The review identified major components of silicon-manganese slag as being silica, alumina, lime and other oxides including those of iron, magnesium and manganese.

The research team explored the potential use of silicon-manganese slag in partially replacing coarse aggregate in concrete and mortar, based on improved compressive and flexural strength.[45] Potential uses as backfill (e.g. in retaining walls) and in cement paste were also identified. The review identified that a ball or rod mill, or a jaw crusher, could function as the primary categories of equipment to reduce slag to a consistently small particle size, which would then enable cement, concrete and aggregate applications. Laboratory and field testing under relevant conditions would be necessary to ensure slag-based formulations could conform to civil engineering standards that may be relevant to a particular application.

Separately, multiple teams have explored the potential use of silicon-manganese slag as a rail ballast material, determining that it may be technically feasible to use the byproduct in this application.[46, 47] However, research in this area is currently in its early phases, and further work is necessary to establish the performance merits of this application.

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[43] G. Osman *et al.*, 'Steel slag and its applications in cement and concrete technology: A review,' *Construction and Building Materials*, Volume 283, 2021, 122783.
[44] https://www.asa-inc.org.au/knowledge/technical-literature/technical-guides
[45] N. H. Wong *et al.*, 'Physicochemical Characteristics of Silicomanganese Slag as a Recycling Construction Material: An Overview,' *Mining, Metallurgy & Exploration*, Volume 41, 2024, 1891–1907.
[46] A. V. Patil and M. P. Anant, 'Behaviour of Silico Manganese Slag Manufactured Aggregate as Material for Road and Rail Track Construction,' *Advanced Materials Research*, May 2011, 3258–62.
[47] R. Oliviera. *et al.*, 'Chemical and mineralogical characterization of silicon manganese iron slag as railway ballast,' *REM – International Engineering Journal*, Volume 70, 2011, 385-391.

The above suggests that there has been some research on the reuse and recycling of silicon-manganese slag, with relevance to the slag produced in Bell Bay. In the nearer term, it is likely that concrete and aggregate applications offer more viable prospects for recovery than others.

A suitable approach from this point may be to engage with the parties liable for this waste stream on potential solutions, and encourage them towards a multi-stage research and development program with the target of identifying a suitable technical path and safe end use for the accumulated slag piles. Pending the results of this program, the next phase would involve investment in the necessary equipment and protocols to recover the slag, while entering into commercial agreements with partners across the supply chain and end customers.

However, irrespective of the research program outcome, the liable party needs to understand its compliance obligations, and act on a management strategy as needed to address risks to the environment and human health. That is, support and encouragement towards research, development and deployment of a solution needs to sit within a broader regulatory safety net to protect the community and the environment. An agreed program of research and development should not be used as an opportunity to indefinitely defer active waste management (including disposal if necessary), with all parties sharing the understanding that a schedule to address the waste needs to be in play with the option to review timeframes based on research results.

Emerging solutions for waste from heavy duty machinery & equipment used in metal smelting, refining & alloying

Damaged and worn heavy duty machinery and equipment as a category may involve a range of streams that differ according to the equipment's function and operational specifications. It may therefore be variously compromised of metals including high performance alloys, ceramics and aggregate, rubber and textiles, polymer material, graphite and other substances. It may or may not be substantially contaminated with raw materials, products, intermediate products, fuels, coatings and lubricants, asbestos, or industrial reagents. Some level of dismantling to remove harmful or ecotoxic components or contaminants may be required.

While recoverable material may almost always be present in the end of life equipment, there is no one size fits all technical solution that may be applied to all heavy duty equipment.

In the absence of putting forward a set of commercially established recovery technologies in this category, it is more constructive to set out some key concepts or principles to provide a supportive commercial and regulatory environment for discovering and operationalising resource recovery solutions. These settings could then be applied to the recovery of heavy duty machinery and equipment that comes from niche sectors, and that cannot be easily, safely and responsibly recovered using existing, general purpose recovery operations.

These principles may include the following, with liability to respond to them resting on the waste generator, and involving compliance as necessary by other parties involved in testing and operationalising a solution. While they are framed in terms of heavy industry machinery and equipment, a research program may equally apply to other forms of controlled waste that lack an established recycling technology.

1. Where a heavy duty machinery or equipment waste stream is consistent with one or more controlled waste codes, and the waste generator intends to research and trial new reuse options that involve the material leaving site (e.g. to undergo one or more processes and/or for use in lab or field trials), this intent should be disclosed to the EPA. Depending on the individual case and the risks involved, the waste generator may need some form of authorisation to undertake a time-bound research program.

2. The purpose of this program should focus on technical, commercial and risk management objectives as needed to establish one or more new recovery options for the waste stream, which are then used to define research questions, specify evidence requirements, and guide research program design in order to generate useful results. The research program may be prepared in stages with periodic review points to assess the need for continuation or revision to forthcoming stages.
3. In determining whether to authorise a research program for the reuse of a controlled waste, the authorising body may have regard to specific details of the research program, but may also need to consider risks associated with how the waste generator proposes to manage any stockpiles of the waste stream that may accumulate over the lifespan of the research program. This consideration may include proposed steps to manage risks as well as the track record of the waste generator in disclosing information and meeting regulatory compliance requirements.
4. The potential safety and environmental risks inherent to the waste stream and/or any derived materials need to be identified and documented across all environments and conditions that they may reasonably come in contact with during a planned research program. Risk planning will inform research program design and long term solution implementation, and all steps involved in handling, transport, testing and experimentation. The waste generator should engage with the EPA on which risks need to be tested, verified and accounted for during a research program and final recovery operations.
5. Volumes of samples required for testing and/or conducting safety and performance trials should involve as small a quantity of material as is practically necessary. Regulatory exemptions (with appropriate conditions) may be necessary to allow offsite transport of these samples, yet should be contained to within specified timeframes and premises, to allow the use of samples to discover and validate resource recovery solutions. The liability for these samples should remain with the waste generator.
6. Some threshold of proof that the recovery application (i.e. recovered materials used in a given commercial or public beneficial setting) is genuine and legitimate needs to be defined and disclosed to regulators (and the WRR Board if it provides project support funds), ahead of launching an approved research program. Examples for illustrative purposes only, may include the substitution of virgin inputs in a commercial supply chain; improved performances of procedures, workflows or products; the enhanced productive value of one or more capital assets; recovery of a commercially saleable commodity; improved environmental performance (beyond reduced disposal of the waste in question) in one or more business operations.
7. Selection of sites for lab trials, field trials, pilot scale experiments and other activities within an authorised research program are to be reflective of risks and commercial opportunities associated with recovering the waste stream. Depending on circumstances, a site remediation plan may need to be included in the research program.
8. In completing the research program, authorisation for a recipient to accept the waste stream (or its derived products) may need to be on the condition that the physical and chemical properties and compositions of future batches stay within a given range of specifications. Authorisations may need to be accompanied with periodic sampling and testing conditions, contingent on the variability and risk inherent to the waste stream (i.e. as a standard condition) and/or in response to significant changes in feedstock, processes and other factors that may affect composition and/or properties (i.e. as testing conditions activated in response to one or more changes affecting the waste stream).

9. The waste generator, waste recipient and/or any parties involved in converting the waste stream to a commercially useful product may be required to disclose progress and issues / incidents to relevant authorities over the research program and to the WRR Board where the Board has provided some form of support. Those parties may also be required to disclose volumes sent, processed and received as part of any ongoing solution after completion of a research program, through updated AER reporting conditions.
10. At any point in time, relevant authorities (i.e. EPA) may determine that the original waste stream no longer represents an outstanding risk as a controlled waste, and for the purposes of environment protection regulation is a recovered byproduct (i.e. no longer covered by relevant controlled waste requirements) which may nonetheless still incur obligations associated with the Dangerous Goods Code and/or workplace safety legislation. Any residual materials that require disposal may need to be separately assessed in terms of whether they constitute a distinct controlled waste stream.

The above draft principles, if seen as relevant and useful, may work as a basis for developing controlled waste research program guidelines, with this development incorporating industry engagement to better understand what conditions are conducive to undertaking research to recover challenging waste streams while managing environmental and other risks. These guidelines will need to provide relevant authorities the confidence that research program risks are being managed, noting that a successful research program may lead to the recovery of a significant quantity of industrial waste.

With an appropriate research program signed off (or substantially progressed), the WRR Board may be in a position to provide support with project funding and/or capital funding awarded to one or more parties involved in the research program. This could include pilot scale funding with potential for larger scale capital grants pending positive research outcomes. There may be additional roles of Department of State Growth or other departments to provide support and/or assistance, depending on the outcomes that the Tasmanian Government hopes to stimulate.

To better contain environmental risks while fostering an array of suitably located capabilities to manage multiple industrial waste streams, the Tasmanian Government may additionally consider designated precincts to fast track circular economy research. These may be sited near different sectors' centres of concentration such as in or near Bell Bay, Burnie, or the west coast.

The above description of how a research program may be authorised and funded is conceptual only. This study has not incorporated a review of WRR Board functions nor environmental protection legislation, and therefore has not ascertained the extent that legislative and/or administrative amendments are necessary.

Characterisation of solutions

Table 7: Emerging solutions for byproduct from metal smelting, refining and alloying

Waste stream: Silicon-manganese slag (metal processing byproduct)	**Solution: Size reduction and use in concrete and civil engineering aggregate**
Technology readiness level	TRL 3 – Analytical and experimental testing of critical performance (as concrete aggregate) has been done by other parties on slag generated elsewhere. Requires replication and additional testing on Tasmanian silicon-manganese samples.
Technical & organisational simplicity to integrate workflows	Assuming initial testing and prototyping of aggregate and cement formulation yields positive results, workflow integration may be relatively straightforward. Air-cooled slag needs to be crushed and screened and transferred to civil projects.
Operational scale compatibility	Mills and crushers needed to size reduce slag via grinding available at a range of scales which may fit with volume available and/or rate of demand for crushed slag aggregate.
Operating risks pertinent to adoption	Key risks relate to the suitability of slag material for a range of civil applications (strength, leaching, pH stability, fatigue resistance and durability etc.). These need to be tested alongside engagement with potential users to confirm demand. Due diligence additionally required in procuring and commissioning appropriate crushing and screening equipment.
Technology limitations	There may be some limitations in the civil engineering settings that can use silicon-manganese slag-derived aggregate and related concretes and sub bases (e.g. due to risk of leaching and/or mechanical instability caused by surrounding conditions).
Logistical and handling requirements	Assuming crushing and screening can take place in Bell Bay, logistical and handling related tasks and overheads may be limited. May additionally be lowered if end civil applications are also located in/near Bell Bay or Launceston (e.g. industrial site planning and civil works within the Bell Bay precinct).
Compatibility with existing regulatory settings	Specification and standards may apply, depending on the civil engineering product and application. Crushing and screening may require permits given noise and dust emissions. There may be additional requirements depending on concerns relating to leaching of metals from crushed slag particles.
Social licence considerations	Significant opportunity to attain social licence for this solution where it removes an otherwise difficult waste stream from a potentially usable industrial site.

Emerging solutions for waste from heavy duty machinery & equipment used in metal smelting, refining & alloying

No specific technical solution was put forward for this priority category of industrial waste stream (given that key features of this stream are highly dependent on the stream in question). See above for suggestions on broader approach to stimulate research and development targeting individual streams.

Action recommendations

Byproduct from metal smelting, refining & alloying

Damaged / worn heavy duty machinery & equipment used in metal smelting, refining & alloying

Priority stream	ANZSIC Industry	Other industries	Solution(s)
Byproduct from metal smelting, refining & alloying e.g. slag, dross, sludges, filter cakes, powders	C – Manufacturing	Other industries that generate processing byproduct that may be a controlled waste	Some byproducts may involve chemistries, inputs and processes that introduce hazards and risks in treating, recycling or reusing the material, that need to be understood and managed. For those that are shown to be relatively safe and inert, size reduction and use in concrete and civil engineering aggregates may be a near term solution. Other solutions that seek to recover higher value materials bound within the byproduct may only be viable after a suitable R&D program is authorised and progressed to completion.
Damaged / worn heavy duty machinery & equipment used in metal smelting, refining & alloying	C – Manufacturing	Other industries that generate heavy duty machinery and equipment waste that may be a controlled waste	A subset of heavy duty machinery and equipment may be mechanically recycled, following decommissioning, clean up / decontamination and dismantling. Other heavy duty machinery may need new solutions to come into play, which may require special conditions to enable piloting and testing, particularly if the items are viewed as or affected by controlled wastes or hazardous materials.

Action	Action area	Lead organisation(s)
Develop a framework for circular economy research program funding by the WRR Board which incorporates a review and authorisation process by EPA (and other authorising bodies as may be suitable), for controlled wastes that may be compatible with new recovery technologies and end markets. Include industry consultation in this framework development process.	Coordinated reforms & enforcement to drive the circular economy Engagement & brokering	EPA WRR Board
Parallel to the above framework development, support a worked example project involving research, development and potential trials for the recovery and use of one to two industrial controlled waste streams, in order to better understand and address dependencies and sticking points between the EPA's and the WRR Board's roles and responsibilities. Adopting this pilot approach may also allow the Board to test an arrangement for how it would engage with and provide support for industrial waste generators while ensuring risks are appropriately managed.	Support for local commercialisation & investment	WRR Board EPA
Plan for and designate precincts or zones that are supported to develop as circular economy research hubs for industrial byproducts and controlled wastes, to help concentrate skills, capabilities and equipment in developmentally suitable sites, and to keep any potential risks and impacts in a limited area.	Spatial mapping & infrastructure planning	WRR Board DSG

Group 6: Other miscellaneous industrial waste streams

- *Boiler ash generated from the timber products industry*
- *Shredder floc*

The industrial streams in this category are priority streams that do not readily lend themselves to other categories, and are treated as miscellaneous. Over time, the Tasmanian Government may become aware of other streams that do not neatly fall into any of the other categories listed in this report, including wastes from industries outside of ANZSIC Divisions A through D.

Boiler ash generated from the timber products industry

The boiler ash stream is a byproduct from to the manufacture of timber products, where a relatively uniform boiler fuel is used to fire a timber kiln. The job of the kiln is to remove moisture from lengths of green timber ahead of being fashioned into timber products. Kiln dried timber is less prone to warping and deformation and improves resistance to insects, larvae, mould and decomposition processes.

As the kilns are powered with shavings and saw dust, it is reasonable to anticipate that the boiler ash is free of or reduced in some of the contaminants found in fly ash or bottom ash generated from burning fossil fuels. While the exact composition of timber kiln ash will depend on the plant species and the operating conditions in the kiln, major constituents of the boiler ash may be silica, oxides and carbonates of calcium and potassium, phosphorus, and trace metal oxides.

Shredder floc

To recap from earlier in this report, shredder floc is produced as a byproduct from the shredding of a wide range of metal-bearing waste streams, which is a core part of metal recycling operations. The generation of shredder floc as is currently observed in at least one premises in northern Tasmania carries the following characteristics:

- Shredder floc is composed of small to very fine particles, which may be susceptible to being wind carried, may accelerate the leaching of various pollutants bound in the material, and may be prone to deeply infiltrate or block biological tissues and organs (e.g. lungs, root systems) and ecological compartments (e.g. soils, waterways).
- The shredder floc originates from highly heterogenous products, industries and materials, which may have been subject to processes that have led to significant loadings of extraneous materials.
- Recent testing of shredder floc on a northern Tasmania recycling premises has indicated elevated levels of heavy metals including lead, such that the premises has been ordered to cease operating its shredder. The premises occupant still receives waste metal but has resorted to baling and stockpiling this metal bearing waste, presumably until such time that the restriction has lifted and shredding may resume.
- Due to limited feedstock management and batch processing methods, there appears to be no practical way of distinguishing floc volumes that are likely to be high in pollutants such as lead, from those that have lower pollutant concentrations.

A large stockpile of shredder floc has accumulated on the abovementioned site occupied by a metal recycler in northern Tasmania. Large sections of the site are now taken up by shredder floc stockpiles as the recycler has not as yet opted to dispose of the material at the Copping C Cell (potentially due to transport and disposal costs). Other sections of the site are taken up by piles of baled metal waste streams such that space is becoming increasingly limited. Surrounding

land parcels, water assets and private and council-owned properties are presently being exposed to lead-contaminated floc particles.

Just as the current stockpiles of shredder floc present a significant industrial waste issue, the stockpiles of baled waste may in turn generate new volumes of shredder floc that carry similar characteristics and risks. There is no indication that the recycler has taken a revised approach to separating and managing batches of metal waste with different risk profiles, ahead of compacting and storing as metal bales. EPA may require that these bales are shredded only once as opposed to being successively shredded into increasingly smaller particle sizes (to extract incremental volumes of copper and aluminium), as a means to partially reduce the risks of pollutants being carried off site.

A future solution for the site may involve investment in revised practices and equipment to separate less contaminated shredder floc from more contaminated shredder floc, which would allow the operator to dispose of some floc as a low risk industrial waste (with a smaller volume requiring disposal in a Category C landfill cell) and improve the options for using the less contaminated material in a recovery application. However, it is unlikely that these changes can safely take place until the shredder floc stockpiles, and possibly shredder floc from the baled material, are taken offsite and managed in a responsible manner.

Potential solutions for recovering these two miscellaneous waste streams

Emerging solutions for boiler ash generated from the timber products industry

A 2022 study from Germany examined the potential use of timber ash sourced from industrial heating plants as a fertiliser, including an analysis of nutrient levels and their speciation, and the presence of different heavy metals.[48] The study found that high levels of nutrients including potassium, phosphorus and calcium were often present alongside minor traces of other nutrients, although they may be accompanied by various metals in different concentrations including lead, arsenic and cadmium.

The authors determined that the precise nutrient and metal profile strongly depended on the species of wood, suggesting that there may be benefit in testing the boiler ash generated by the timber industry in Tasmania. Having an accurate and repeatable profile of nutrients and contaminants in the boiler ash may help the timber industry market the boiler ash as a premium fertiliser input, rather than as a waste stream where use as a fertiliser input is merely seen as improvement over landfill disposal.

Adding to the above, the timber industry boiler ash is notable in having very low moisture levels while containing significant concentrations of valuable nutrients. This may favour its role as a suitable blending agent with compatible streams that are impacted by high moisture content – such as biosolids, hydro-excavation sludge or alum sludge.

A suitable pathway for using the boiler ash may be to prepare and test different samples of ash blended with other waste streams that would otherwise be directly applied in land spreading, to determine whether a premium soil additive exhibiting superior results can be prepared from these materials. This investigation could commence with an initial compositional testing (chemical assay) and desktop formulation and analysis approach, to understand the presence and behaviour of chemicals of concern, while also aiming to optimise the blend of ash with other

[48] E. Mayer *et al.*, 'Utilization and recycling of wood ashes from industrial heat and power plants regarding fertilizer use,' *Waste Management*, Volume 141, 2022, p.92-103.

materials to arrive at an optimal balance of nutrients and physical attributes (moisture retention, spadability etc.) for one or more applications.

Academic research has also been undertaken on the use of wood ash as an additive in cement replacement applications such as in cement-wood particle board panels (with up to 30% replacement of cement).[49] A Canadian team determined that a proportion of cement could be replaced with wood ash in the manufacture of wood-cement composite panels, with only minor reductions in compressive strength. In the Canadian market, such panels are used in exterior cladding, roof shingles, and tiles.

More recently, a Sweden based team published an extensive literature review of the use of wood ash in concrete applications and found that a replacement level of 10% to 20% may be optimal, depending on the application. The team additionally concluded that further research was needed – particularly with respect to studying durability impacts.[50] A similar literature review conducted by a team based in the Baltic states examined the use of wood ash in activated-alkali materials (which are in effect alternatives to concrete that substitutes cement with other materials to act as a binder), and found similar results.[51]

Summarising the above, the more immediate options for putting timber industry boiler ash to use appear to involve:

- Further development as a fertiliser or soil additive, with more dedicated effort to optimise formulations that potentially involve other industrial waste streams
- Exploration of cement and activated-alkali material applications, potentially involving 10% to 20% replacement of the binder material with wood ash, with research needing to cover lab scale and field scale formulation and testing alongside an investigation into potential supply chains, products and end markets.

Emerging solutions for shredder floc

There have been limited studies or explorations into the use of shredder floc in different applications in Australia and elsewhere. In 2013-14, Sustainability Victoria commissioned research into potential applications for shredder floc generated in Victoria.[52] The research identified that there are examples of using shredder floc as landfill daily cover in Australia. However, the report did not provide details on whether such daily cover volumes were notably contaminated with heavy metals; and did not provide information on whether the feedstock materials shredded to generate the shredder floc (i.e. used for daily cover) were controlled and batch processed in a way to reduce risks from elevated heavy metals and other substances.

While it may be appealing to apply shredder floc as daily cover at face value, it would presumably be a better practice to use the most inert, least contaminated materials available to the landfill as daily cover, as opposed to using a material that is known to be contaminated with lead and other heavy metals. Thus, daily cover could be an option for shredder floc produced in

[49] V. A. Vu *et al.*, 'The Effect of Wood Ash as a Partial Cement Replacement Material for Making Wood-Cement Panels,' *Materials*, Volume 12 (17), 2019, p.2766.
[50] E. Teker *et al.*, 'Wood Ash as Sustainable Alternative Raw Material for the Production of Concrete—A Review,' *Materials*, Volume 16, 2023, p.2557.
[51] Y. Du *et al.*, 'A Review of Biomass Wood Ash in Alkali-Activated Materials: Treatment, Application, and Outlook,' *Journal of Composites Science*, Volume 8(5), 2024, p.161.
[52] https://studylib.net/doc/7461028/shredder-floc---sustainability-victoria

Tasmania, but may not be suitable for the current stockpiles or any future volume of shredder floc where the recycler cannot ensure confidence that all contaminants are safely managed.

The report additionally points to shredder floc processing technologies involving mechanical separation to separate heavy and light fractions, with the light textile fraction used as an input for producing coke or as an input into a waste to energy facility; and the heavy inert fraction used for land contouring and in road construction. The report points to PCBs as being a potential source of contamination, additional to heavy metals, that may preclude some uses. But more generally, the report does not provide any details on the types of metal waste streams that have constituted the shredder floc used in these applications, so it is difficult to determine the applicability of these findings given the wide array of metal wastes that may be shredded.

In 2014, OneSteel Recycling sought approval from NSW EPA to build a plant that would separate heavy and light fractions of shredder floc, with the intent to pyrolyse the light fraction to produce a crude fuel oil; and use the inert heavy fraction as an aggregate. At the time of writing, it appears that this application is suspended, although no reasoning is given for this decision.[53]

Summarising the above, indicative applications for shredder floc include the following:

- Use as daily cover (made of grit, glass, ceramics, dirt, and other trace materials), using a heavy fraction of the shredder floc that has been separated from a lighter fraction
- Use of a heavy fraction of shredder floc in various civil applications, such as road base, backfill, or possibly as a cement additive
- Use of the lighter fraction (major constituents being plastics, foams and textiles plus other trace materials) as a feedstock in energy from waste technologies such as gasification and pyrolysis – noting that it may be unrealistic to expect sufficient quantities of light shredder floc generated in Tasmania to justify investment in a pyrolysis unit, in the absence of other viable feedstocks.

All of the above options must be predicated on the certainty that the shredder floc in question is safe for these applications. The current attention towards managing different input streams subject to metal recycling in Tasmania, and the results of testing that show elevated levels of lead and other toxins, suggest that existing stockpiles of shredder floc would be unsuitable for the above applications, with disposal being the preferred option.

This finding may also apply to the baled metal waste which is awaiting recommencement of shredder operations, as the baling process does not seem to have involved a high level of pre-sorting to avoid cross contamination between highly contaminated sources and low contaminant sources. Similar issues with contamination may therefore persist when these bales are shredded, and this may warrant the need for sampling and testing of shredder floc from these bales before adopting a given disposal strategy.

The introduction of improved practices to inspect and manage inputs, shred in batches, and separate and store shredder flocs according to their risk levels would open up the possibility of one or more recycling options as presented above, for less contaminated categories of shredder floc. However, the recycling operator may not be able to progress this improvement due to the extensive stockpiles of shredder floc onsite, and their impact on free space. This adds to the

[53] https://www.planningportal.nsw.gov.au/major-projects/projects/resource-recovery-facility-shredder-floc-waste

urgency of removing the shredder floc, i.e. beyond the mounting impacts of pollutants dispersing into the surrounding environment.

Referencing *EPA Information Bulletin 105*, the presence of lead and other heavy metals in the shredder floc suggests that the waste should be disposed of at a Category C landfill cell. The only Category C cell lies in southern Tasmania, which may incur high gate fees and high transport costs given the northern location of the metal recycling facility.

There may be a need to expedite removal of this shredder floc, with one option being for the WRR Board to subsidise some disposal costs on behalf of the operator, strictly limited to the current stockpiles of shredder floc (i.e. not including shredder floc volumes that occur after shredding recommences). To avoid a repeating pattern, any offer to absorb any disposal costs may be contingent on the metal recycler reviewing their operations and preparing a plan:

- To better segregate input metal waste streams according to contamination risk, including a high standard of practice to inspect, remove and reject items that lead to high contamination, and potentially black list clients and visitors with a poor track record
- To batch process metal waste streams using the shredder according to contamination profile, with separate storage of shredder flocs in accordance with risk levels
- To undertake differentiated disposal options (Category C landfill cell when necessary, other landfills when compliance requirements can be met) according to risk profile
- To undertake ongoing sampling and testing activities to ensure segregation protocols work, with a testing plan reflective of likely contaminants across and beyond the site
- To disclose the performance and results from this change in operations on an agreed periodic frequency with EPA, including sampling and testing results
- That sets out a scheduled timeframe of implementation stages and investments in suitable equipment, training and upgrades to site layout and workflows.

EPA authorisation to allow recommencement of shredder operations may be contingent on the recycling operator's agreement to those or similar conditions (plus other unrelated conditions), to provide a level of certainty that future risks are being managed at an appropriate level.[54] But while these conditions may be read as a minimum standard to ensure shredder floc risks are being adequately handled, satisfactory improvements at the recycling facility may also open a pathway for the operator to access support for a circular economy research program (as discussed above, under Category 5) that could unlock new shredder floc recycling opportunities.

Further to the above, any WRR Board offering to share in the cost of disposal for the existing stockpiles of shredder floc may be restricted to a proportion of the transport costs only, to avoid the moral hazard associated with accepting the disposal liability (i.e. landfill gate fee) for a third party business. The WRR Board should avoid the precedent of accepting the commercial costs associated with the responsible disposal of industrial wastes, where those costs rightly reside with a third party per the 'polluter pays' principle.

For future volumes of shredder floc generated and disposed of to landfill, it is essential that the operator and its competitors fully internalise (and where appropriate, pass through) their waste transport and disposal costs along with other operating costs, to provide an incentive to lower

[54] Queensland Government released a best practice guide for scrap metal recycling facilities operating shredders in 2024, and may be a useful reference for lifting standards in Tasmania. https://www.des.qld.gov.au/policies?a=272936:policy_registry/pr-gl-fragmentiser-best-practice.pdf

volumes and risks associated with that waste, and to drive interest in legitimate recycling activities for at least those types of shredder floc that are suitable for recycling.

Moreover, this may require a shift in expectations on those that bring metal scrap to a recycler without having to pay a fee, in cases where the metal scrap contains high levels of floc material and/or high risk substances. For these scrap items, a 'no fee' pricing model may not be tenable, and effectively transfers the cost of residual waste disposal to the recycling operator. If this lack of cost pass through leads to an erosion of operating standards, the environment and the local community may ultimately bear the consequences in the form of increased pollution risks.

Characterisation of solutions

Table 8: Emerging solutions for boiler ash generated from the timber products industry

Waste stream: Wood ash from timber drying kiln boiler	**Solution: Blending with other materials to produce a nutrient optimised fertiliser / soil improver**
Technology readiness level	TRL 2/3 – Some analysis of wood ash soil nutrients and chemicals of concern has taken place elsewhere in an academic setting, but needs to be applied to ash from the Tasmanian timber industry. Foundational studies on possible soil improvement / fertiliser blends using e.g. biosolids, hydro-excavation sludge and alum sludge need to be conceptualised and planned. Techno-economic assessment to confirm extent of demand for nutrient-optimised soil improver and price tolerances.
Technical & organisational simplicity to integrate workflows	There is a lack of information on possible workflow integration issues, given potential need to screen boiler ash and/or dewater other soil additive components, and allow time for soil additive material to mature or stabilise. Some controls (e.g. dust suppression, odour prevention) may be needed during blending. There may be some timing issues (e.g. intermittent production of alum sludge) that may also introduce complications.
Operational scale compatibility	Operations to blend different soil improvement additives to a given formulation expected to be highly scalable and may be able to fit with Tasmanian volumes of boiler ash production.
Operating risks pertinent to adoption	Key risks relate to the suitability of slag material for a range of civil applications (strength, leaching, pH stability, fatigue resistance and durability etc.). These need to be tested alongside engagement with potential users to confirm demand. Due diligence additionally required in procuring and commissioning appropriate crushing and screening equipment.
Technology limitations	Limitations to the application of boiler ash as a soil nutrient to be determined through testing and techno-economic assessment.
Logistical and handling requirements	Logistical and handling requirements may be modest if blending and storage can take place close by to major timber drying operations (e.g. Bell Bay precinct).
Compatibility with existing regulatory settings	Depending on results from an analysis of chemicals of concern that may be present in boiler ash and other blend inputs, regulatory requirements may be modest.
Social licence considerations	Significant opportunity to attain social licence for this solution where it improves the quality of productive land while lowering risks associated with alternative land spreading materials.

Waste stream: Wood ash from timber drying kiln	Solution: Addition to concrete and activated-alkali materials as a substitute for binder
Technology readiness level	TRL 3 – Analytical and experimental testing of critical performance (as a partial replacement for cement and other binders) has been undertaken by other parties in an academic setting. Foundational studies at the laboratory scale is needed for concretes and activated-alkali materials, using Tasmanian boiler ash at 10% to 20% replacement levels. Strength, permeability, durability and other properties require testing, alongside techno-economic assessment including demand from different customer bases.
Technical & organisational simplicity to integrate workflows	Boiler ash may require a level of screening (and coarse residues crushed) before being fed into concrete blending processes. Other workflows may relate to storage and dust suppression, and batch testing to ensure specifications are met. Depending on results, there may be a need to update mixing protocols and/or review concrete curing conditions.
Operational scale compatibility	It is not known whether the volume of boiler ash generated works at a compatible scale with the volume of concrete (and activated-alkali material alternatives) produced in Tasmania – this needs to be confirmed via sector engagement.
Operating risks pertinent to adoption	At this stage, many of the workflow, end market applications and customer concerns are not well understood – as such there may be a range of operating risks that need to be assessed.
Technology limitations	Laboratory and field testing activities are required to assess technology limitations (i.e. compared to the standard performance of concrete in one or more use cases).
Logistical and handling requirements	Screening, storage and packaging for transport may all potentially be undertaken close to existing timber drying kilns, which will help to minimise logistical and handling costs.
Compatibility with existing regulatory settings	Specification and standards may apply, depending on the civil engineering products and applications that use concretes and activated-alkali materials with ash as a substitute for binder.
Social licence considerations	Given the high carbon intensity of cement production, new concrete products that substitute up to 20% of cement binder with boiler ash may be seen as highly worthwhile.

Emerging solutions for shredder floc

A solution assessment for shredder floc reuse and recycling solutions has not been undertaken as yet, given the need to address existing stockpiles of heavy metal contaminated shredder floc through appropriate disposal. Production and characterisation of cleaner shredder floc streams that display consistent, low risk features may precede an assessment of potential applications.

Action recommendations

Boiler ash generated from the timber products industry (from combusting wood chip and sawdust fuel)

Priority stream	ANZSIC Industry	Other industries	Solution(s)	
Boiler ash generated from the timber products industry (from combusting wood chip and sawdust fuel)	C – Manufacturing		Solutions are presently emerging, and may include the following: • Use as an additive to produce nutrient optimised fertiliser or soil improver • Use as a substitute for binder in concrete and activated-alkali materials (low carbon concrete substitutes).	
Action			Action area	Lead organisation(s)
Engage with timber industry on participating in research projects for using boiler ash in concrete and/or nutrient optimised soil improver applications. This research is likely to require initial trials to formulate and test relevant properties (i.e. specific to the application being investigated), ahead of proceeding with field trials to test the modified concrete or soil improver in commercially relevant settings. Pending results from these research programs, the WRR Board may consider other avenues (e.g. development of specifications and standards, funding for scaled up production) to stimulate high volumes of boiler ash reuse in Tasmania.			Support for local commercialisation & investment	WRR Board DSG

Shredder floc generated by metal recycling activities

Priority stream	ANZSIC Industry	Other industries	Solution(s)
Shredder floc generated by metal recycling activities	D – Waste & recycling		No immediate solutions involving reuse or recovery are available for the shredder floc currently stockpiled onsite, due to high loadings of lead and other metals. Similar findings may hold for baled metal feedstocks and future feedstocks that are shredded and generate floc as a byproduct, where insufficient effort has gone into controlling the concentration of heavy metals and other chemicals of concern in different stockpiles of shredder floc. In other states, there has been investigation in separating low contamination shredder floc into heavy and light fractions, and use of those fractions as daily cover, as inert aggregate, and as a pyrolysis feedstock. These may be explored in Tasmania, pending EPA's satisfaction that metal shredding activity may be resumed in one or more metal recycling facilities that generate shredder floc.

Action	Action area	Lead organisation(s)
Resolve the removal of accumulated shredder floc and stored at metal recycling facility, noting the potential to look into addressing transport costs associated with disposal to the current Category C landfill cell in southern Tasmania for existing stockpiles of floc (not baled metal items), if and only if conditions relating to establishing best practices at the facility are agreed to by the site occupant and demonstrated through a site operational upgrade plan in line with best practice. This action prioritises the need to make space available onsite to enact upgraded metal recycling workflows and stockpile management, to minimise risks and open up opportunities for reuse and recovery for shredder floc generated in future operations.	Support for local commercialisation & investment	WRR Board EPA
Allow commencement of metal shredding operations if and when agreed milestones on improving onsite operations are met, to deliver best practice risk management and segregation of stockpiles according to contaminant loading.	Coordinated reforms & enforcement to drive the circular economy	EPA
Pending site occupant compliance and cooperation on the above actions to drive best practice, engage with the metal recycling sector on an appropriately designed and funded R&D program for the reuse of metal recycling shredder floc, where there is high confidence in the compositional consistency, inputs, processing operations and risks associated with the shredder floc and the reuse applications under investigation.	Support for local commercialisation & investment	WRR Board EPA

5.4 Findings as they relate to strategic drivers

In October 2023, the WRR Board released the *Tasmanian Waste and Resource Recovery Strategy 2023-2026*. As the first strategy released by the WRR Board, it is framed as follows:[55]

> *'It is the first part of a two-stage response that aims to achieve a structural shift over the next six to seven years. It sets foundations and initial priorities, identifies actions to boost reuse and repair and the demand for long-life, reusable, repairable products and recycled materials, sets up programs to drive change, and boosts our collective ability to respond to emerging challenges and opportunities. It sets the scene for further waste and resource recovery strategies and programs after 2026.'*

In short, the current strategy focuses on setting priorities and laying foundations for a more action-oriented subsequent phase. In this light, the project can take the opportunity to help set the Board's direction and priorities for managing industrial waste across Tasmania, commencing with a focus on northern Tasmanian wastes. The above listed waste streams indicate a starting point for priority materials generated by activities associated with ANZSIC Industry Divisions A through D, and there are likely to be other priorities arising from other sectors.

Equally important, the exploration of potential solution technologies and supply chains (linked with specific products and end uses) gives rise to an understanding of the types and possible locations of investment across recovery supply chains, as needed to drive circular economy outcomes for those materials and align with the waste hierarchy (Figure 10).

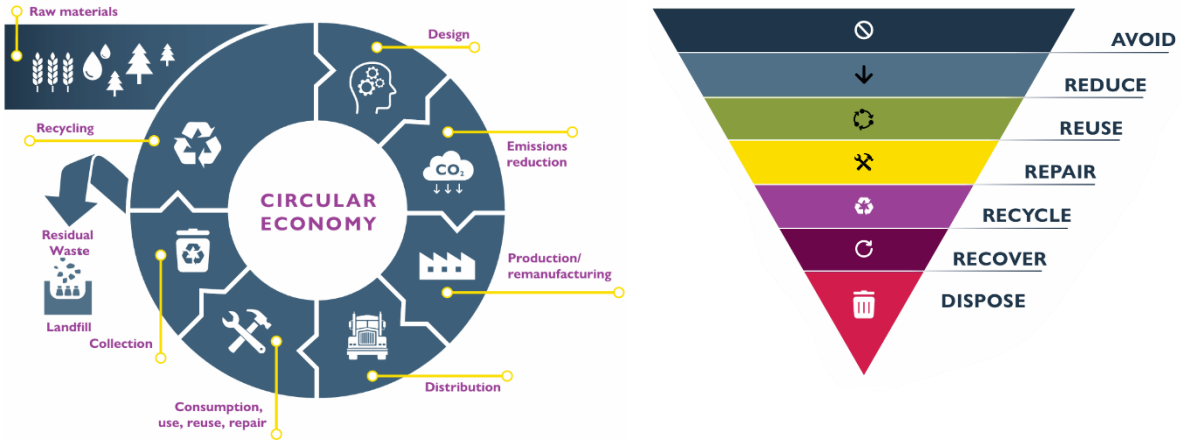

Figure 10: Circular economy and waste hierarchy concepts as set out in the *Tasmanian Waste and Resource Recovery Strategy 2023-2026*.

The discussion of actions and interventions needed to drive this investment – with initial considerations for action put forward as recommended Next Steps throughout the preceding sections of this chapter – suggest a scope of activities that the WRR Board may embark on during the remainder of the current strategy period and into the next period.

These activities may require corresponding shifts in approach from other authorities, such as the EPA, where the waste stream in question is a controlled waste or is implicated in substantial environmental risks. Some of these links between different roles and accountabilities are

[55] Waste and Resource Recovery Board, *Tasmanian Waste and Resource Recovery Strategy 2023-2026*, p. 10.

explored as general findings in the next chapter, i.e. without specific attachment to any one priority stream or industry.

The *Tasmanian Waste and Resource Recovery Strategy* sets out three purposes driving the strategy, which are set out below (Table 9). A summary is provided in terms of how the project findings respond to these purposes and position the WRR Board to deliver on them.

Table 9: Links between the current project and *Tasmanian Waste and Resource Recovery Strategy* purposes.

Strategic purpose	**Relevance of project findings**
To support the creation of a strong circular economy that will reduce the generation of waste and greenhouse gas emissions, and improve the amenity, liveability, and sustainability of Tasmania.	• The report sets out an approach for industrial wastes and byproducts to be repurposed as useful resources, through the active use of new recovery infrastructure and through direct transfer of some byproducts from one industry to another, pending outcomes from suitable R&D projects and trials and confirmation that risks are accounted for. • GHG emissions reductions are achievable through the recovery of streams that have high levels of embodied energy (plastics, tyres, metals); through displacement of fossil fuel energy sources in industrial energy applications; and displacement of energy intensive industrial inputs (e.g. replacement of cement in concrete products). • Improvements to amenity and liveability are progressed in this work through solutions to address accumulated stockpiles (of slag, shredder floc, mining equipment waste and concrete waste), to reduce marine plastics (ropes, nets etc.), and to reduce the prevalence of land spreading practices.
To have a future where we divert products and materials from landfill and the inherent value of products and materials is recognised.	• The project maps out potential solutions, products and end markets suitable for 12 priority industrial waste streams, and measures to place those streams on a path to retrieve their inherent value. • Diversion from landfill is one result from taking action, although some of the waste streams covered in this report are implicated in low grade land spreading, onsite accumulation with localised impacts, and placement in mining voids and pits.
To improve and invest in critical programs to bring about change, in the recovery and reuse of priority products and materials, and in responding to emerging resource recovery issues.	• The report sets out a structured approach to further investigating and establishing an evidence base for investment in solutions across 12 identified industrial waste priority streams, corresponding to the extent that these technologies have proven themselves elsewhere. Pending outcomes of these investigations, the WRR Board and other parties will have a clear basis for investing with confidence. • Gaps in supply chains are also identified, providing a path to de-risk investment in new infrastructure and provide growth opportunities for Tasmanian businesses. • The project has identified and navigated paths to balance out investment stimulus with environment protection to ensure trade offs are optimised, to avoid tensions between competing responsibilities, and to underwrite the social licence for new solutions. • The approaches put forward may be applied to emerging priority streams, as well as being used to attract co-investment from private businesses, other Tasmanian departments and agencies, and other tiers of government.

6 Wider issues faced in recovering industrial wastes

During stakeholder engagement activities for this project, the team uncovered a range of issues and concerns in relation to how industrial waste was being managed in Tasmania, with stakeholders drawing attention to a range of external factors and drivers that may potentially impede higher value, circular economy solutions for some industrial wastes. The project team also separately identified some widely applicable issues that were not raised by industry stakeholders, but were nonetheless apparent in completing this project and amassing information from a range of disparate sources.

These issues may have a bearing on multiple industries and waste streams, i.e. they cut across the priority streams and related discussions laid out in the preceding chapter, and may also be relevant to industries outside the present scope and that may be prioritised by the WRR Board in future. The recommendations below, which seek to address these broader issues, should be interpreted in conjunction with individual actions put forward in Chapter 5.

As a separate area of exploration, it is understood that there has been business interest in exploring whether a Category C cell for high contamination soils and other wastes may be justified for the north of Tasmania (complementing the existing Category C cell located near Hobart). Further waste flow mapping by the WRR Board, focused on industrial activities outside of ANZSIC Industry Divisions A through D, may useful in ascertaining the need for a Category C landfill cell in northern Tasmania.

The results of this current project do not provide a compelling case for this infrastructure, particularly if better risk-based segregation of shredder flocs and recycling options for other wastes (e.g. slag stockpiles and PFAS contaminated biosolids) lead to a diminished demand for Category C landfill services from businesses based in the north of the state.

Recommendations to address broader issues

1. Continue industrial waste stream mapping and volume analysis to understand gaps in the location and capacity of infrastructure and services for other industries – particularly with niche waste streams, e.g. marine, health, construction & agriculture.

2. Strengthen the resilience and confidence in recovery supply chains and waste contractors that can assist in transitioning to the circular economy. This should include industry guidance to help businesses procure more effective, transparent and proactive waste contractors, and support for pretreatment and handling activities that streamline recycling supply chains.

3. Develop a priority list of streams involving waste management practices that do not involve landfill disposal (and avoid landfill levy costs), yet those practices inhibit higher value circular economy outcomes from being achieved. Prepare action plans to close off the use of those practices in cases where they displace solutions that more closely align with the waste hierarchy and that achieve higher value circular economy outcomes. (Examples may include the use of mining voids to deposit recyclable items; land spreading unprocessed organic streams that may involve trace pollutants; stockpiling recyclable equipment and consumable waste over indefinite timeframes, and so on.)

4. Develop a set of threshold questions / criteria and internal guidance for their application, to determine whether a proposed circular economy initiative genuinely represents a suitable recovery outcome that warrants support and encouragement, and enhances the social licence of the circular economy. Their application may need to involve some level of flexibility given the range of initiatives that commercial leads may put forward. Key questions may centre on the following as indicative areas to inform a determination:
    - Whether the proposed solution involves recovery of commercial value (beyond avoidance of landfill gate fees and landfill levy payments), and the evidence used to demonstrate this value
    - The opportunity costs associated with granting permission for or supporting the proposed solution, including impacts on investment in alternative solutions
    - The extent that permitting or supporting the proposed solution may have short to longer term impacts on the environment and community, and whether this permission or support impairs confidence in how the landfill levy is reinvested.

5. Collaborate with EPA and other authorities (e.g. workers safety, emergency response) to develop a broader framework on a circular economy for controlled wastes (building on other individual actions mentioned in the report). This framework may aim to balance environment protection duties with incentives for innovation, while addressing areas of regulatory ambiguity that may otherwise contribute to deferred investment in solutions.

6. Implement a compositional audit program for 'general waste' generated by relevant industries. The selection and design of categories, methods and timeframes for conducting audits should take into account the details and features that are specific to those participating industries.

7. Develop a set of standards of evidence and arguments necessary in making a funding allocation from the Waste and Resource Recovery Account, commensurate with the capital being applied to a given project or program (i.e. Circular Economy Investment Thesis or similar). Develop a template and internal guidance for setting out this evidence and supporting arguments to underpin Board funding allocation decisions and authorisations.

8. Longer term and strategically focused engagement and relationship building with industry may be a cornerstone to addressing industrial waste streams and moving towards a circular economy for each industry. The Board is recommended to actively weigh up and assess options to appoint high performing and productive engagement officers / organisations, to work with targeted industries in areas of greatest need and opportunity. Authorised engagement and delegation decisions should include adequate, time-bound and independent review and evaluation mechanisms in line with sound governance principles.

The WRR Board is encouraged to review, consider and implement each of these actions at its earliest convenience, given their fundamental value in ensuring a credible investment environment for solution providers, and in building the evidence base for targeted, prudent public interventions and investments.

Appendix A – stakeholder engagement

The following organisations were engaged with over the course of this project. Other organisations and businesses associated with ANZSIC Industry Divisions A through D (with Division A limited to aquaculture) were also reached out to but were not forthcoming with a response.

In engaging with those parties listed below, the project received valuable input in relation to waste volumes, types, management practices and destinations.

Useful information was provided on priority and challenging waste streams, and the types of management solutions that were seen to accord with corporate objectives and aspirations. Other perspectives were also shared, including factors and drivers that were seen to enable as well as inhibit the shift towards practices that are more aligned with the waste hierarchy and achievement of circular economy goals.

- Tasmanian Minerals Manufacturing and Energy Council (TMEC) Environmental Committee
- TasWater
- HydroTasmania
- Abel Energy / Bell Bay PowerFuels
- Timberlink Australia
- Cement Australia
- Rio Tinto Aluminium (Bell Bay Aluminium)
- MMG Ltd
- Grange Resources Ltd
- Launceston Waste Centre
- Dulverton Waste Management
- Heybridge Landfill
- Recycal
- NextGen Industrial Services
- Circular North
- Cradle Coast Authority
- AusIndustry
- Business NorthWest
- Launceston Chamber of Commerce

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